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ABSTRACT

This curriculum guide contains a course in civil drafting to train entry-level workers for jobs in the field. The module contains 12 instructional units that cover the following topics: (1) introduction to civil drafting; (2) map scales and measurement; (3) standard symbols and abbreviations; (4) interpretation of surveyor's notations; (5) legal land descriptions; (6) map drafting procedures; (7) plats and subdivisions; (8) topographic mapping; (9) transportation mapping; (10) municipal mapping; (11) structural drafting; and (12) computer applications. Each instructional unit follows a standard format that includes some or all of these eight basic components: performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests. All unit components focus on measurable and observable learning outcomes and are designed for use in more than one lesson or class period. (KC)

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CIVIL DRAFTING

Written by

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CIVIL DRAFTING

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FOREWORD

For many years those responsible for teaching drafting have felt a need for competency-based instructional materials. To address this need, MAVCC has previously published two texts, *Basic Drafting, Book One*, and *Basic Drafting, Book Two*. During the development of these basic materials, an even greater need was established, that being supplemental instructional materials to help the students specialize in various areas of drafting. Teachers, industry representatives, teacher educators, and state supervisors who have served on the developmental committees have accepted this challenge and have completed specialized publications to follow-up the basic books.

Civil Drafting is now added to the list of other publications (*Mechanical Drafting, Architectural Drafting, Light Commercial Drafting, Pipe Drafting, Electronic Drafting,* and *Residential Solar Systems.*) These specialized publications are designed to be used in addition to the first two publications, and are developed to strengthen student competency in specialized fields of drafting.

This publication is designed to assist teachers in improving instruction. As this publication is used, it is hoped that the student performance will improve so the students will be better able to assume a role in their chosen occupations. Every effort has been made to make this publication readable and by all means usable. Three vital parts of instruction have been intentionally omitted (*motivation, personalization,* and *localization*). These areas are left to the individual instructors who should capitalize on them. Only then will this publication become a vital part of the teaching-learning process.

Greg Pierce
Executive Director
Mid-America Vocational
Curriculum Consortium

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Chairman, Board of Directors
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USE OF THIS PUBLICATION

Instructional Units

Civil Drafting contains twelve units. Each instructional unit includes some or all of the basic components of a unit of instruction; performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated

   1. Supplies needed
   2. Equipment needed
   3. Amount of practice needed
   4. Amount of class time needed for demonstrations

C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which is a necessary prerequisite to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

CIVIL DRAFTING

INSTRUCTIONAL/TASK ANALYSIS

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)

UNIT I: INTRODUCTION TO CIVIL DRAFTING

RELATED INFORMATION	JOB TRAINING
1. Terms and definitions	
2. Required skills of a civil drafter	
3. Job responsibilities of a civil drafter	
4. Major employment opportunities for a civil drafter	
5. Organization structures for design teams in small and large firms	
6. Specialty areas for civil engineering firms	
7. Occupations related to civil drafting	
8. Major classes of maps	
9. Typical drawings used in civil drafting	
10. Drafting equipment used by civil drafters	
	11. Take basic math pretest
	12. Interview a civil drafter
	13. Research possible employment opportunities in civil drafting in your local area

UNIT II: MAP SCALES AND MEASUREMENT

RELATED INFORMATION	JOB TRAINING
1. Terms and definitions	
2. Standard measures and their equivalents	
3. Characteristics of map scales	
4. Ways map scales are expressed	

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
5. Ranges of map scales	
6. Factors affecting the selection of a map scale	
7. Types of maps and their common scales	
8. Characteristics of a quadrangle scale	
9. Quadrangle scales commonly used on U.S.G.S. topographic maps	
10. Characteristics of graphic scales	
11. Published map accuracy standards	
12. Types of scales used in civil drafting	
	13. Convert a representative fraction to a graphic scale
	14. Read a vernier scale
	15. Measure with a civil engineer's scale

UNIT III: STANDARD SYMBOLS AND ABBREVIATIONS

1. Terms and definitions
2. Common types of symbols used in civil drafting
3. Abbreviations commonly used in civil drafting
4. Factors that determine when an abbreviation should be used
5. Purposes of symbols on maps
6. U.S.G.S. topographic map symbols
7. Other conventional topographic symbols
8. Boundary, fence, and track fixture symbols
9. Civil symbols

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
10. Utility and service symbols	
11. Hydrographic and navigation symbols	
12. Geological structure symbols	
13. Oil and gas symbols	
14. North arrow symbols	
15. General rules for drawing map symbols	
16. Methods used in drawing symbols	
17. Color codes and map symbols	
18. Common material symbols used in structural and architectural drawings	
19. Standard symbols for pipe fittings	
20. Common welding symbols	
	21. Set up a map legend
	22. Locate and identify symbols and features on a U.S.G.S. map

UNIT IV: INTERPRETATION OF SURVEYOR'S NOTATIONS

1. Terms and definitions
2. Survey methods to determine distances and positions of points
3. Types of horizontal and vertical angles
4. Principal surveying equipment
5. Types of surveys
6. Stationing
7. Field notes
8. Arrangement of field notes in the field book

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
9. Methods of recording field notes	
10. Examples of types of field notes	
11. Traverses	
12. Differences between a bearing and an azimuth	
13. Formulas used to convert bearings to azimuths and azimuths to bearings	
14. Common methods for plotting traverses	
	15. Plot lines and distances using several methods
	16. Convert azimuths to bearings and bearings to azimuths
	17. Layout a closed traverse
	18. Complete a mathematical closure of a traverse
	19. Reduce four types of field notes
	20. Draw a map using bearings, distances, and coordinates

UNIT V: LEGAL LAND DESCRIPTIONS

1. Terms and definitions
2. Methods of legal land descriptions
3. U.S. public land survey system
4. Subdivision of a section
5. Lot and block descriptions
6. Metes and bounds descriptions
7. Components used to develop a plat

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
8. State plane coordinates	
9. Common legal aspects of land acquisition	
	10. Answer questions based on the U.S. public land survey system
	11. Write and locate descriptions for the subdivision of a section
	12. Write a lot and block description
	13. Identify components used to develop a plat

UNIT VI: MAP DRAFTING PROCEDURES

1. Terms and definitions
2. Types of drafting media
3. Characteristics of scribing
4. Types of photographic block-out products
5. Types of lettering used in civil drafting
6. Rules for good lettering
7. Methods of map registration
8. Reprographic techniques
9. Types of pressure-sensitive films
10. Methods used for coloring maps
11. Aerial photography
12. Methods of drawing reproduction
13. Standard sheet format for a set of civil drawings
14. Components of a map layout

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
15. Steps for drafting a map or drawing	
16. Common mistakes made in map drafting	
17. Types of planimeters	
18. Parts of a polar planimeter	
	19. Complete a tracing in ink of a mapped area
	20. Apply transfer film and press-on letters
	21. Register a map
	22. Use a polar planimeter to determine acreage

UNIT VII: PLATS AND SUBDIVISIONS

1. Terms and definitions
2. Subdivision planning
3. Official agents who may regulate subdivision planning
4. Duties that may be performed by regulatory agents for the subdivision of land
5. Steps in planning a subdivision
6. Final recordation of a subdivision plat map
7. Individuals who certify and approve the final plat map
8. Legal descriptions
9. Guidelines for drafting a plat
10. Methods for laying out and developing a map

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RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
	11. Layout a boundary survey from a legal description
	12. Reduce field notes and plot a simple boundary survey
	13. Develop from field notes the plat map for a nine lot subdivision
	14. Redraw to scale a complete final plat of a 36 lot subdivision
	15. Research the plat information for your property or a property in your area

UNIT VIII: TOPOGRAPHIC MAPPING

1. Terms and definitions
2. Uses of topographic maps
3. Types of surveys used in topographic mapping
4. Field methods for obtaining topography
5. Factors affecting the selection of the field method to be used for a topographic survey
6. Horizontal and vertical controls for topographic surveys
7. Steps in laying out a topographic survey
8. Methods used to establish contours with the correct descriptions
9. National standards for horizontal and vertical accuracy on topographic maps
10. Scale ratios used in the U.S.G.S. topographic series
11. Selection of contour intervals

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

12. Characteristics of contour lines
13. Contour line configurations
14. Common methods used to calculate area from a topographic map
15. Steps in calculating cut and fill using the contour area method
16. Steps in developing and plotting a profile from profile leveling notes
17. Steps used to develop a profile from a contour map
18. Methods for plotting contour lines
19. Fixing a grade line
20. Aerial photogrammetry
21. Advantages and disadvantages of using aerial photography for mapping work
22. Applications of aerial photogrammetry
23. Aerial photo control
24. Steps for using a stereoscope

JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

25. Interpolate contours from a grid survey and prepare profiles from the contour map
26. Set up contours in isometric
27. Calculate grades in percents

UNIT IX: TRANSPORTATION MAPPING

1. Terms and definitions
2. Purpose of route surveys
3. Fundamentals of a route survey

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
4. Superelevated roadways	
5. Elements of a horizontal circular curve	
6. Mathematical formulas used for computing a horizontal curve	
7. Circular curve layout by tangent offsets	
8. Vertical curves	
9. Plan views for route surveys	
10. Characteristics of profiles for a route survey	
11. Characteristics of cross sections for a route survey	
12. Field note reduction for a cross section	
13. Plotting cross sections	
14. Methods used to determine areas of cross sections	
15. Formulas for calculating earth volume	
16. Drawings included in a set of highway plans	
17. Common horizontal and vertical scales used in transportation mapping for rural and urban areas	
18. Items that appear on a typical title sheet for a set of highway plans	
19. Detail sheets	
20. Drafting of plan views, profiles, and cross sections	
	21. Layout open traverses using several methods
	22. Layout a survey alignment for a road using bearings and coordinates
	23. Plot field notes for horizontal control, topography, profile, and cross section for a proposed road

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
UNIT X: MUNICIPAL MAPPING	
1. Terms and definitions	
2. Types of utilities	
3. Agencies who develop and maintain municipal maps	
4. Users of municipal maps	
5. Types of drawings used in municipal mapping	
6. Methods of presenting utilities on maps	
7. Surveying and mapping of municipal maps	
8. Support information needed to develop utility drawings for a specific area	
9. Utility easements	
10. Types of valves and valve housings	
11. Types of gas piping and devices	
12. Information included on utility drawings	
13. Types of sewers and sewer lines	
	14. Research the plats for local utilities
	15. Draft a map of all utilities for a local area
UNIT XI: STRUCTURAL DRAFTING	
1. Terms and definitions	
2. Definition of structural drawing	
3. Types of structures	
4. Types of materials used for structures	

	RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
5.	Types of steel members	
6.	Structural steel shapes	
7.	Drawing practices for steel members	
8.	Placement of gage lines for steel members	
9.	Fastener sizes and spacings	
10.	Dimensioning procedures for steel structures	
11.	Structural steel callouts	
12.	Structural steel marking	
13.	Anchor bolts	
14.	Types of concrete	
15.	Types of concrete reinforcement	
16.	Standard prestressed concrete units	
17.	Foundation parts	
18.	Types of structural drawings for concrete	
19.	Standard symbols and abbreviations for concrete placing drawings	
20.	Standard practices for documentation of rebar	
21.	Examples of typical details for concrete structures	
22.	Wood construction	
23.	Types of wood connectors	
24.	Types of framing connectors	
25.	Components of wood construction	

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
26. Heavy timber construction	
	27. Prepare detail drawings of structural steel members
	28. Draw to scale a concrete engineering drawing
	29. Detail a wood truss

UNIT XII: COMPUTER APPLICATIONS

RELATED INFORMATION: What the Worker Should Know (Cognitive)	JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)
1. CAD equipment terms and definitions	
2. CAD terminology and definitions	
3. Hardware used in a CAD system	
4. Data input	
5. Data output	
6. Digital and interactive computer graphics	
7. Types of computer drawings	
8. Methods of storing graphic information	
9. Advantages of using computers for mapping applications	
10. Computer applications for civil mapping	
11. Parts of an interactive data management system for mapping	
	12. Research computer applications in the civil drafting field

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INTRODUCTION TO CIVIL DRAFTING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the duties and responsibilities of a civil drafter, and identify kinds of maps and drawings used by civil drafters. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to an introduction to civil drafting with the correct definitions.
2. Select required skills of a civil drafter.
3. List job responsibilities of a civil drafter.
4. List major employment opportunities for a civil drafter.
5. Distinguish between organization structures for design teams in small and large firms.
6. List specialty areas for civil engineering firms.
7. Select occupations related to civil drafting.
8. Identify major classes of maps.
9. Match major classes of maps with the correct characteristics.
10. Match typical drawings used in civil drafting with the correct uses.
11. Identify drafting equipment used by civil drafters.

OBJECTIVE SHEET

12. Take basic math pretest. (Assignment Sheet #1)
13. Interview a civil drafter. (Assignment Sheet #2)
14. Research possible employment opportunities in civil drafting in your local area. (Assignment Sheet #3)

INTRODUCTION TO CIVIL DRAFTING
UNIT I

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Upon completion of the math pretest, evaluate what specific areas may need further development and provide additional work sheets that students may complete.
2. Write and send for different kinds of maps of your local area available through government agencies.
3. Make a field trip to a large civil engineering firm to see the different kinds of civil drafting work being done.
4. Invite a civil drafter into the classroom to talk about working in the field of civil engineering and its job duties and educational requirements.
5. Invite a civil engineer into the classroom to speak about requirements expected of the civil drafter such as math and drafting skills.
6. Demonstrate special drafting tools as they apply to civil drafting.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

   1. TM 1 — Typical Geographic Map
   2. TM 2 — Typical Topographic Map
   3. TM 3 — Typical Cadastral Map
   4. TM 4 — Typical Engineering Map
   5. TM 5 — Geologic Map
   6. TM 6 — Aeronautical Chart
   7. TM 7 — Kinds of Surveying and Mapping
   8. TM 8 — Typical Title Sheet
   9. TM 9 — Typical Plan and Profile
   10. TM 10 — Typical Roadway Cross Section
   11. TM 11 — Typical Structural Details
   12. TM 12 — Other Civil Drawings
   13. TM 13 — Typical Intersection Detail
   14. TM 14 — Planimeters
   15. TM 15 — Types of Curves
   16. TM 16 — Civil Head Drafting Machine
   17. TM 17 — Stereoscope
   18. TM 18 — Scribing Tools
   19. TM 19 — Other Specialty Tools
   20. TM 20 — Other Specialty Tools (Continued)

D. Assignment sheets

   1. Assignment Sheet #1 — Take Basic Math Pretest
   2. Assignment Sheet #2 — Interview a Civil Drafter
   3. Assignment Sheet #3 — Research Possible Employment Opportunities in Civil Drafting in Your Local Area

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN WRITING THIS UNIT

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B. *Glossaries of BLM Surveying and Mapping Terms,* 2nd ed. Bureau of Land Management/U.S. Department of the Interior, 1980.

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D. Nelson, John A. *Drafting for Trades and Industry: Civil.* Albany, NY: Delmar Publishers, 1979.

E. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

F. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

G. Bies, John and Robert Long. *Mapping and Topographic Drafting.* Cincinnati, OH: South-Western Publishing Co., 1983.

H. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

I. Brown, Walter. *Drafting for Industry.* South Holland, IL: Goodheart-Wilcox Company, Inc., 1978

J. State Board for Community Colleges. *Occupational Analysis Civil Technology.* Denver, CO, Publication No. OA37, Dec. 1979.

K. Wirshing, Roy and James Wirshing. *Civil Engineering Drafting.* New York: McGraw-Hill Book Co., 1983.

INTRODUCTION TO CIVIL DRAFTING
UNIT I

INFORMATION SHEET

I. **Terms and definitions**

A. CAD — Computer-aided drafting or design

B. Cadastral map — A map showing the boundaries of subdivisions of land with bearings, lengths, and areas of individual tracts, for purposes of describing and recording ownership

C. Cartography — The science of map making

D. Civil drafter — A drafter used to support civil engineering with the preparation of technical materials

Examples: Maps, engineering calculations, interpretation of surveying notes, and data related to the design of civil projects

E. Civil engineer — A person who has completed a minimum of 4 years of college and has specialized in civil-related engineering

F. Civil engineering — A discipline concerned with the design and construction of various municipal and state projects for the general public, such as bridges, roads, dams, canals, and pipelines

G. Contour line — A line used to connect points on a land surface that have the same elevation

H. Elevation — Altitude or height above sea level

I. Geodetic survey — A precise survey of considerable extent which takes into account the shape of the earth

J. Geographic — Signifying basic relationship to the earth considered as a globe-shaped body; applies to data based on the geoid and on the spheroid

K. Map — Graphic representation of the earth's surface drawn to scale on a plane surface

L. Pantograph — An instrument for copying maps and drawings at a predetermined reduction or enlargement

M. Planimeter — A device for measuring small areas by mechanical integration

N. Plan view — A view as seen from directly above the land

O. Profile — An outline of a cross section of the earth

P. Stereoscope — An optical instrument used for viewing two properly related photographs or diagrams simultaneously to obtain the impression of a 3-dimensional object

INFORMATION SHEET

Q. Surveying — Determining and representing accurately on paper the area of any portion of the earth's surface, the lengths and directions of the boundary lines, and the contour of the surface by taking linear and angular measurements and by applying the principles of geometry and trigonometry

R. Topography — The configuration or shape of the land surface of any area

S. U.S.G.S. — United States Geological Survey

II. **Required skills of a civil drafter**

(NOTE: Civil drafting skills can be acquired from a vocational-technical school or community college that offers a drafting program.)

A. Basic drafting techniques in line work, lettering, and the use of tools and equipment

B. Math skills up through trigonometry

C. Good communication skills

D. Recognition of map symbols and abbreviations

E. CAD training

F. Drafting applications and calculations for:

1. Basic surveying
2. Drafting of maps and plans
3. Topographic mapping
4. Cut and fill

III. **Job responsibilities of a civil drafter**

A. Prepare maps and plans

(NOTE: To correctly prepare maps and plans, the drafter must be able to use reference materials and manuals, drafting equipment, and appropriate symbols and abbreviations, as well as lay out plan sheets and prepare working drawings from sketches and notes.)

B. Work with survey data

Examples: Reduce field notes, plot contours, lay out bearings and azimuths, lay out boundary surveys and strip surveys

C. Gather, organize, and record data

D. Perform engineering calculations

Examples: Reduce field notes, calculate traverses, closures, area and volume, horizontal and vertical curves, earthwork volume, horizontal and vertical angles, strengths of material, and state plane coordinates

INFORMATION SHEET

E. Assist in the drafting and design of:

  1. Subdivisions
  2. Surface drainage systems
  3. Major structures
  4. Water treatment facilities
  5. Water distribution facilities
  6. Storm sewer systems
  7. Transportation systems
  8. Utility facilities

F. Communicate effectively

Examples: Write reports, work as a team member, lead a work team, prepare graphic exhibits

IV. Employment opportunities for a civil drafter

A. Private civil engineering and surveying firms

(NOTE: Civil engineering and surveying firms are located in every state, and many hire both permanent, full-time civil drafters and free-lance civil drafters as well as many other employees.)

B. Local government agencies

  1. County planning offices
  2. City planning department
  3. Highway department
  4. Water department
  5. Engineering and planning office
  6. Parks and recreation department

C. Federal government agencies

  1. Department of Transportation
  2. Bureau of Census
  3. Defense Mapping Agency (DMA)
  4. Department of the Interior
  5. Department of Agriculture

INFORMATION SHEET

6. Bureau of Indian Affairs
7. All energy regulatory agencies
8. Corp of Engineers
9. Soil Conservation
10. Department of Commerce

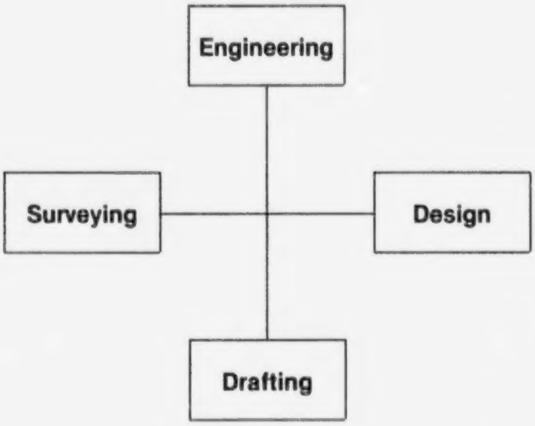
    (NOTE: Other agencies may be available in your area.)

V. **Organization structures of design teams in civil engineering firms**

(NOTE: Each firm is individual in the way they organize their line of responsibility.)

A. Small civil engineering firms

  1. Are less structured
  2. Usually have ten or fewer staff members
  3. The drafter will have many different job responsibilities.
  4. Communication is usually by word of mouth.

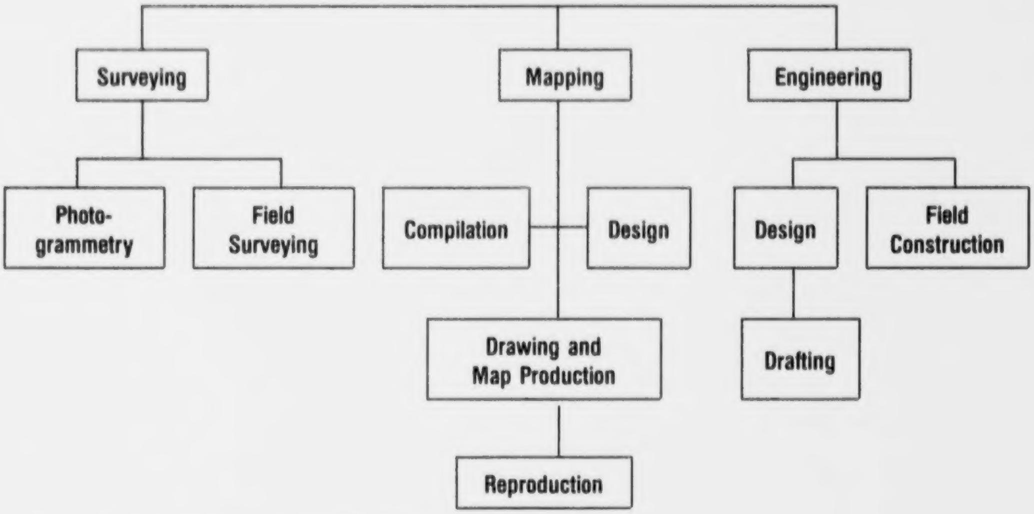


B. Large civil engineering firms

  1. Have specific lines of authority and responsibility
  2. Are able to specialize in a specific area of drafting or mapping

INFORMATION SHEET

3. Usually have an organizational/standards manual which will include personnel policies and technical procedures


Surveying
Mapping
Engineering
Photo-grammetry
Field Surveying
Compilation
Design
Design
Field Construction
Drawing and Map Production
Drafting
Reproduction

VI. **Specialty areas for civil engineering firms**

(NOTE: Some civil engineering firms specialize in only one area, while other larger companies are more diversified and perform work in many of these areas.)

A. Land planning and subdivision

B. Transportation

C. Flood control

D. Irrigation and drainage

E. Sewage and water treatment

F. Municipal improvements

G. Environmental studies

H. Land and construction surveys

I. Construction inspection

J. Refuse disposal

K. Map making

L. Power plants

INFORMATION SHEET

M. Hydrologic studies

N. Foundation work and soil analysis

O. Agribusiness

P. Structural

VII. Occupations related to civil drafting

(NOTE: With additional training and/or experience, a civil drafter could move into the following occupations.)

A. Cartographic drafter

B. City planning aide

C. Estimator

D. Civil engineering technician

E. Instrument surveyor's assistant

F. Map maker

G. Planning assistant

H. Surveyor's helper

I. Construction materials testing technician

J. Traffic technician

K. Topographic drafter

VIII. Major classes of maps (Transparencies 1—5)

(NOTE: Maps are classified on the basis of their purpose or intended use.)

A. Geographic (Transparency 1)

B. Topographic (Transparency 2)

C. Cadastral (Transparency 3)

D. Engineering (Transparency 4)

(NOTE: There are many different specialty maps not shown in this unit, but most are based on one of the above four classifications.)

INFORMATION SHEET

IX. Characteristics of maps

A. Geographic maps (Transparency 1)

1. Show large area of land
2. Are drawn to a small scale
3. Only show major features such as rivers, lakes, and dots for cities
4. Scales vary from a few miles to the inch to several hundred miles to the inch.
5. Examples can be found in an atlas.

B. Topographic maps (Transparency 2)

1. Represent surface features of a region
2. Large scale maps show all the natural features down to small streams and man-made features such as city streets, bridges, pipelines, etc.
3. U.S.G.S. topographic maps are the most widely known maps in this class.
    a. Are always bounded by meridians of longitude and latitude
    b. Are made to the following scales:

        1:24,000 — 1" = 2000 FEET
        1:62,500 — 1" = nearly 1 mile
        1:125,000 — 1" = nearly 2 miles
        1:250,000 — 1" = nearly 4 miles
4. Use contour lines to show elevation
5. Contour maps showing principally the elevation of the land are used for location, estimating costs, and construction.

C. Cadastral maps (Transparency 3)

1. Are used primarily for showing political and civil boundaries, property lines, taxation, and transfer of property
2. Are considered legal documents
3. Are drawn on a large scale — usually greater than 6 inches to a mile

INFORMATION SHEET

4. May contain or show
    a. Property lines — All lengths and bearings of boundary lines
    b. Some natural features to help locate lines on the ground
    c. Acreage
    d. Record of land ownership
    e. Future planning and growth
    f. Location of gas mains, water lines, and sewer lines

5. Examples include plats of city additions, mineral rights, and farm surveys.

D. Engineering maps (Transparency 4)

1. Are drawn for reconnaissance, construction, or maintenance purposes

2. Scale is seldom smaller than 1" = 400 ft and sometimes uses architectural scales.

   Example: 1/8" equals 1'

3. May include topographic information

4. Can show more detail than a usual topographic map since they are larger in scale

5. Examples are maps for railroad, highway, canal, and hydroelectric construction, building site maps, landscape maps, and dam and reservoir maps.

E. Other maps (Transparencies 5 and 6)

1. Aeronautical charts — Show air traffic routes, radio and electronic aids, obstructions, and elevations of high points.

2. Hydrographic charts — Show shorelines, water depths, information about harbors, anchorage details, and shipping approaches.

   (NOTE: Additional information can be obtained from the National Ocean Survey and the Lake Survey Center.)

INFORMATION SHEET

3. Maps based on geodesic data

    a. Geodesy is a branch of science and mathematics that determines the exact position of figures, points, and areas along the curvature of the earth.

    b. Examples are geologic maps and specialty maps for location sites of minerals and energy sources.

(NOTE: The type of map often correlates to a specific type of survey. Refer to Transparency 7 for a chart showing the kinds of surveying and mapping.)

X. **Typical drawings used in civil drawing**

A. Title sheets (key maps) (Transparency 8)

1. Identify the project with a name and number
2. Show location map of the project
3. Give an index to all sheets in the plan set

B. Plan and profiles — Are drawings composed of a plan view and profile view (usually located directly below the plan) (Transparency 9)

(NOTE: The plan and profile as used by civil engineers and state highway departments can be compared to a top and section view in mechanical drafting.)

C. Typical cross sections (Transparency 10)

1. Are views of the inside of the project cut open at right angles to the survey centerline
2. Types of cross sections
    a. Natural ground cross section
    b. Typical section
    c. Roadway cross section
    d. Cut and fill cross section

D. Structural details (Transparency 11)

1. Provide a close-up look at how a particular structural component is made
2. Show materials, dimensions, and section where needed

INFORMATION SHEET

E. Pictorial drawings — Provide the viewer a three-dimensional view of the map area. (Transparency 12)

F. Schematic diagrams — Are details that may show connections and flow directions through the use of symbols, lines, and dimensions. (Transparency 12)

G. Intersection details — Are enlarged drawings of an intersection of several streets that come together; show all pertinent information such as dimensions, right-of-ways, centerlines, and curve data. (Transparency 13)

XI. **Drafting equipment used by civil drafters**

(NOTE: Most drafting offices use the same basic drafting tools. In this unit, only specific tools used by civil drafters will be covered. Refer to MAVCC's *Basic Drafting, Book I* for basic drafting tools.)

A. Planimeters (Transparency 14)

B. Curves (Transparency 15)

  1. Ship curves
  2. Flexible rule curves
  3. Highway radius curves
  4. Railroad curves

C. Civil head drafting machine (Transparency 16)

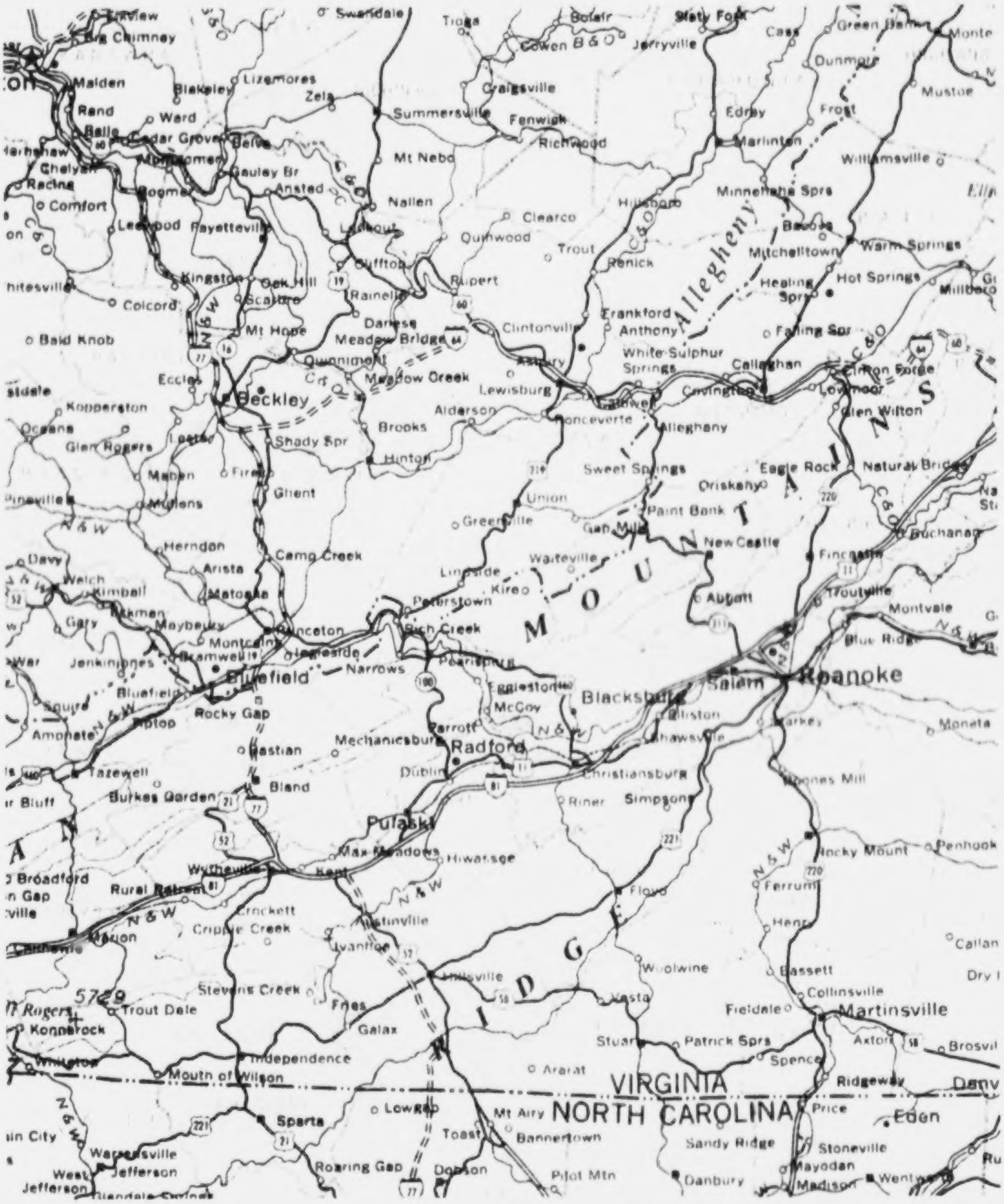
D. Stereoscope (Transparency 17)

E. Scribing tools (Transparency 18)

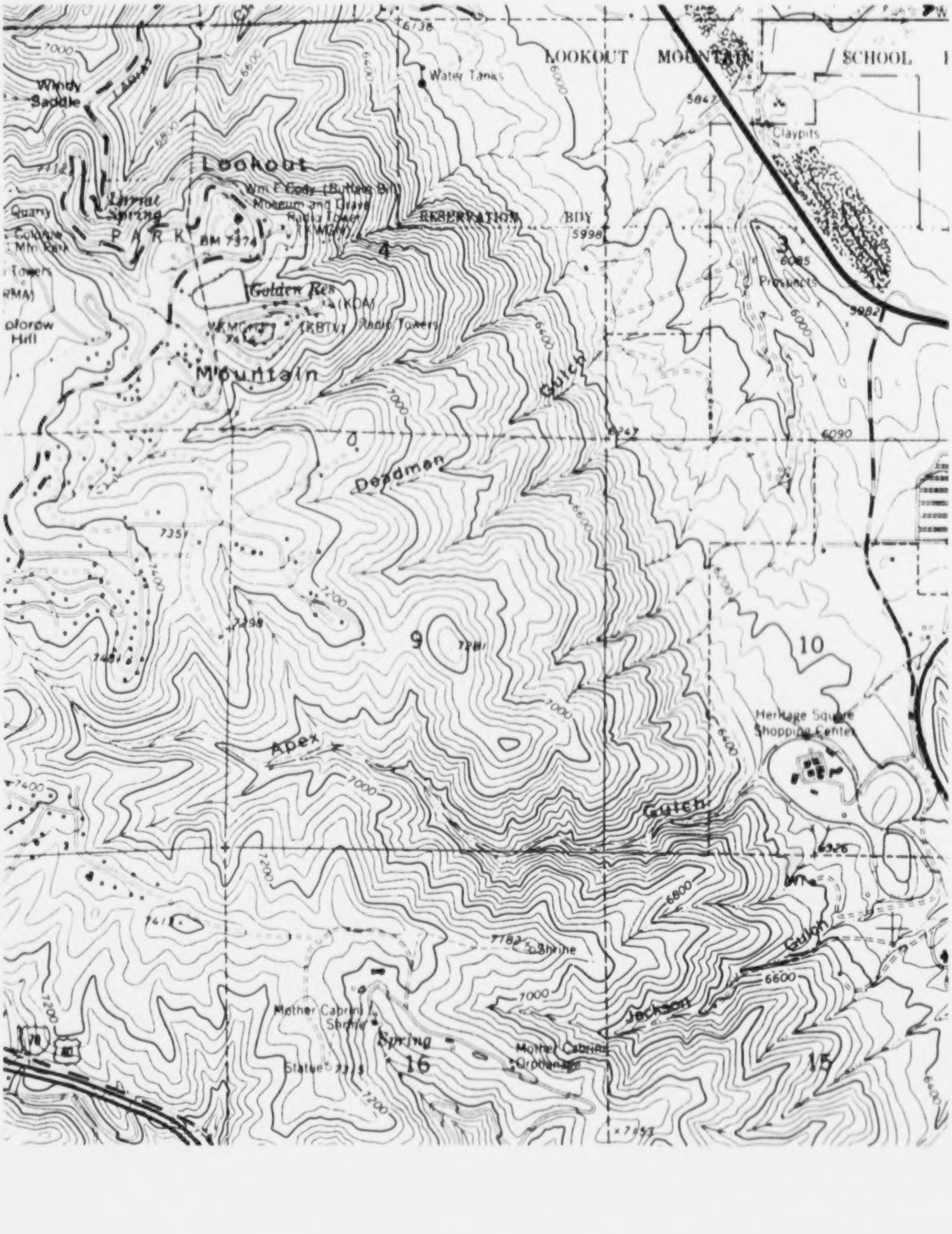
F. Other specialty tools (Transparency 19)

  1. Pantograph
  2. Beam compass
  3. Proportional dividers
  4. Spacing dividers
  5. Map measures
  6. Kern dotting pen and wheel

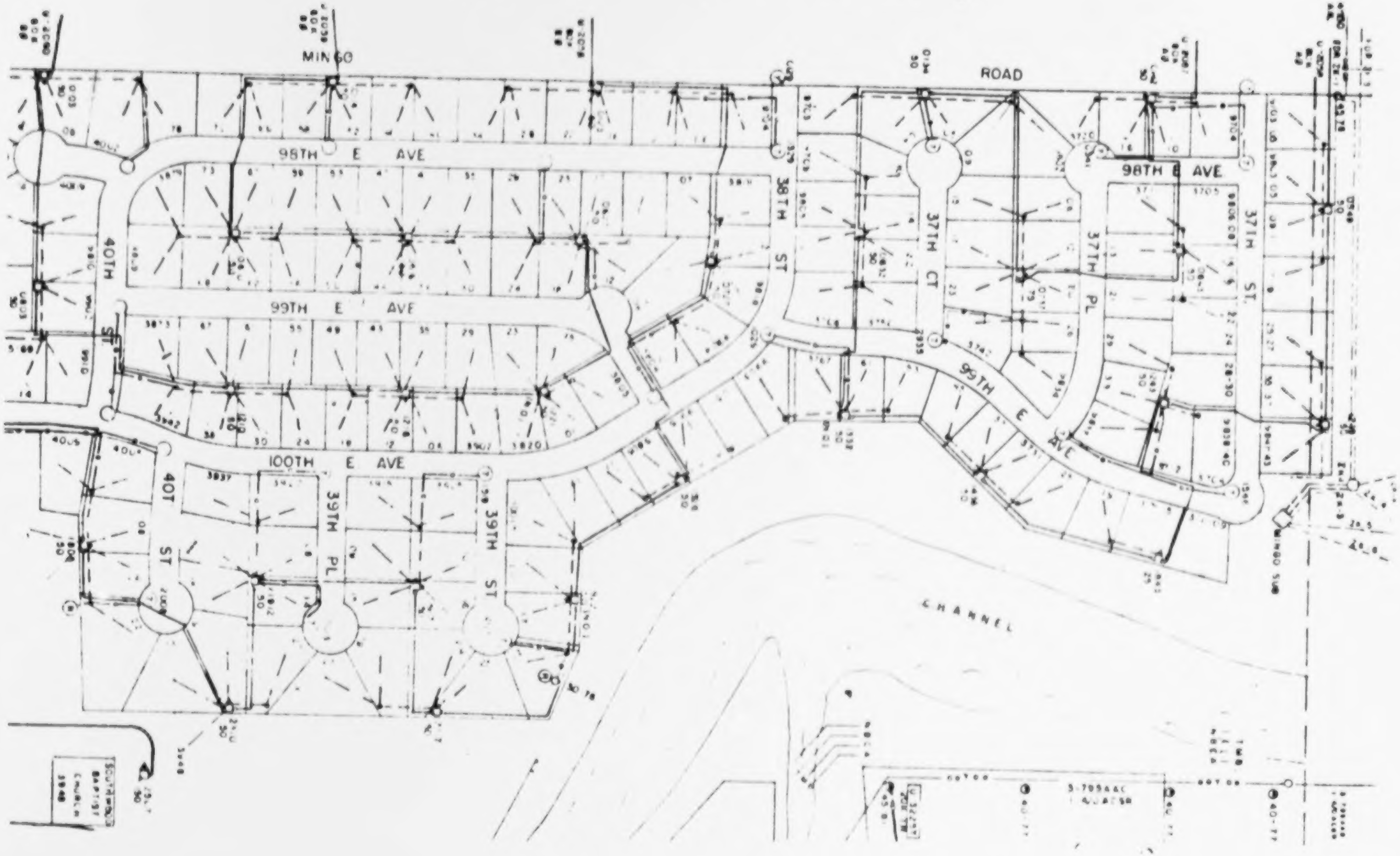
Typical Geographic Map


Swandale
Tioga
Belair
Slaty Fork
Cass
Green Bank
Big Chimney
Cowen B & O
Jerryville
Dunmore
Malden
Blakeley
Lizemores
Craigsville
Mustoe
Rand
Ward
Zela
Summersville
Fenwick
Edray
Frost
Belle
Cedar Grove
Richwood
Marlinton
Williamsville
Montgomery
Mt Nebo
Chelyan
Racine
Gauley Br
Ansted
Minnehaha Sprs
Comfort
Nallen
Hillsboro
Clearco
Leewood
Fayetteville
Lookout
Quinwood
Trout
Bacova
Mitchelltown
Warm Springs
Renick
Allegheny
Kingston
Oak Hill
Cliftop
Rupert
Healing Sprs
Hot Springs
Millboro
Colcord
Scarbro
Rainelle
Frankford
Anthony
Bald Knob
Mt Hope
Danese
Meadow Bridge
Clintonville
Falling Spr
Quinnimont
White Sulphur Springs
Callaghan
Clifton Forge
Eccles
Meadow Creek
Lewisburg
Covington
Lowmoor
Beckley
Kopperston
Alderson
Caldwell
Ronceverte
Alleghany
Glen Wilton
Oceana
Glen Rogers
Lester
Shady Spr
Brooks
Hinton
Sweet Springs
Eagle Rock
Natural Bridge
Oriskany
Mullens
Fireco
Ghent
Union
Paint Bank
Pineville
N & W
Greenville
Gap Mills
New Castle
Buchanan
Herndon
Camp Creek
Waiteville
Fincastle
Davy
Arista
Lindside
Welch
Kimball
Matoaka
Peterstown
Kire
Abbott
Troutville
Montvale
Gary
Maybeury
Princeton
Rich Creek
MOUNTAINS
Blue Ridge
War
Jenkinjones
Bramwell
Montcalm
Ingleside
Narrows
Pearisburg
Eggleston
Blacksburg
Salem
Roanoke
Bluefield
Rocky Gap
McCoy
Ellison
Amonate
Tiptop
Bastian
Mechanicsburg
Parrott
Radford
Shawsville
Moneta
Tazewell
Dublin
Christiansburg
Boones Mill
Burkes Garden
Bland
Riner
Simpsons
Pulaski
Max Meadows
Hiwassee
Rocky Mount
Penhook
Broadford
Wytheville
Kent
Rural Retreat
N & W
Ferrum
Crockett
Cripple Creek
Austinville
Henry
Marion
Ivanhoe
RIDGE
Callands
Woolwine
Bassett
Collinsville
Stevens Creek
Hillsville
Fries
Vesta
Fieldale
Martinsville
5729
Mt Rogers
Trout Dale
Galax
Stuart
Patrick Sprs
Axton
Brosville
Konnarock
Independence
Spencer
Mouth of Wilson
Ararat
VIRGINIA
Ridgeway
NORTH CAROLINA
Lowgap
Mt Airy
Price
Eden
Sparta
Toast
Bannertown
Sandy Ridge
Stoneville
Warrensville
Jefferson
West Jefferson
Roaring Gap
Dobson
Pilot Mtn
Danbury
Mayodan
Madison
Wentworth

Typical Topographic Map


Windy Saddle
Lookout
Wm F Cody (Buffalo Bill) Museum and Grave
Radio Tower (KWGN)
BM 7374
PARK
Quarry
Colorow Hill
Golden Res
(KOA)
(KBTV) Radio Towers
Mountain
Water Tanks
LOOKOUT MOUNTAIN SCHOOL
RESERVATION BDY
Claypits
Prospects
4
3
9
10
15
16
Gulch
Deadman
Apex
Gulch
Heritage Square Shopping Center
Shrine
Mother Cabrini Shrine
Spring
Mother Cabrini Orphanage
Statue
Jackson
Gulch
6000
6400
6600
6800
7000
7200
7400

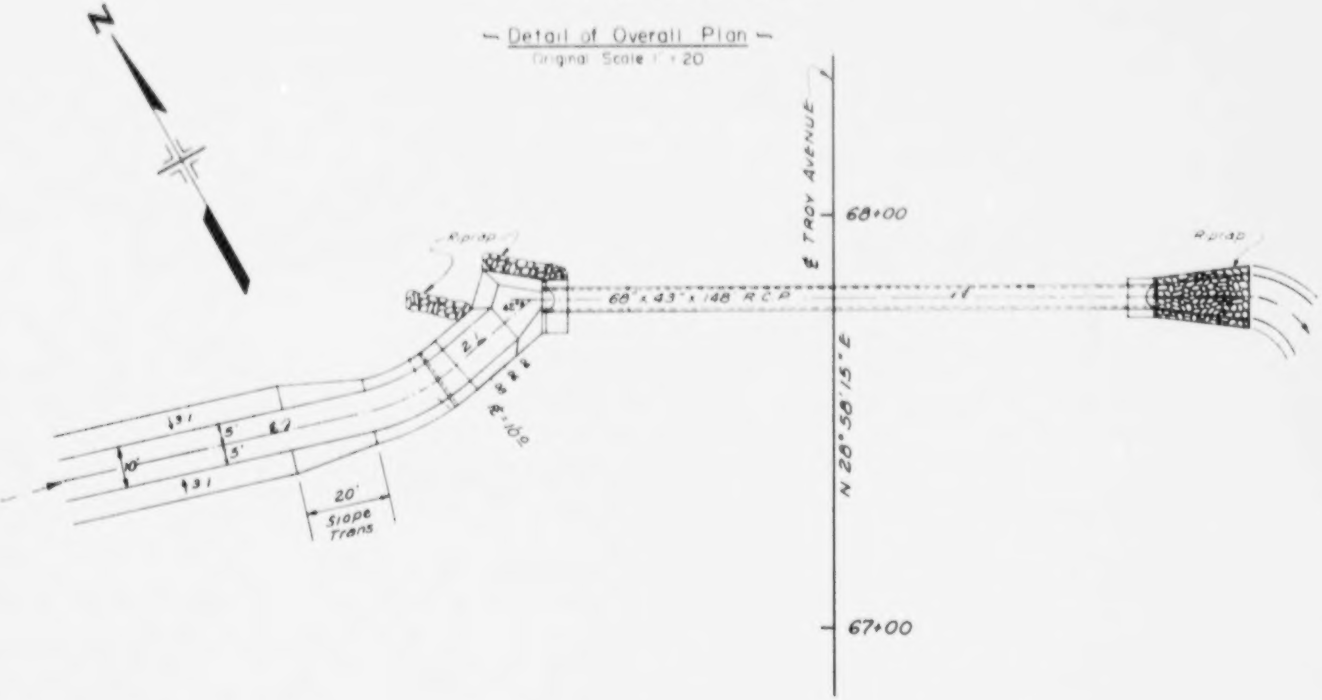
Typical Cadastral Map


MINGO
ROAD
98TH E AVE
99TH E AVE
100TH E AVE
98TH E AVE
99TH E AVE
40TH ST
40T ST
39TH PL
39TH ST
38TH ST
37TH CT
37TH PL
37TH ST
CHANNEL

Typical Engineering Map

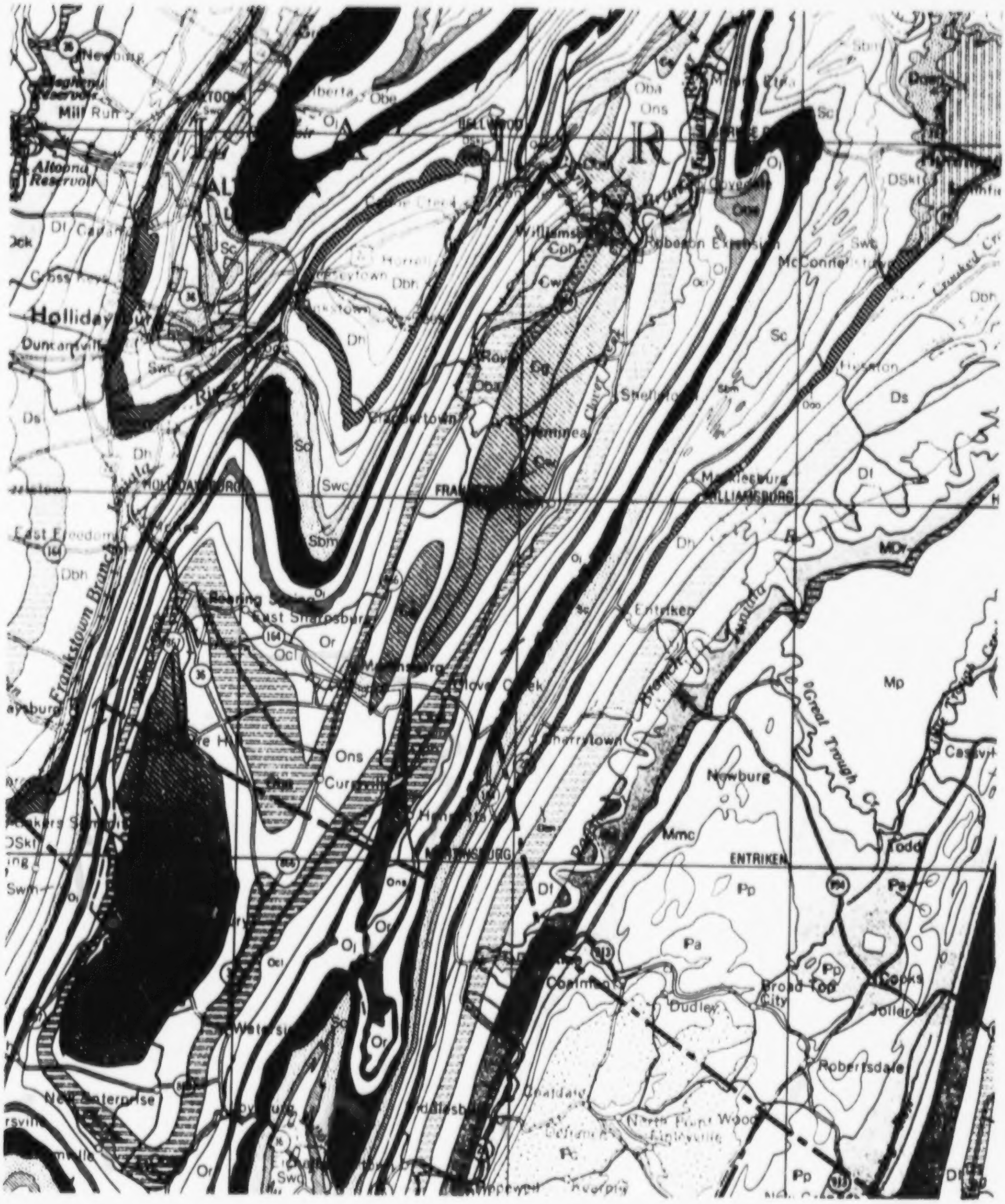
DETAIL OF DRAINAGE PLAN

TROY AVE - Sta 67 +


N
— Detail of Overall Plan —
Original Scale 1" = 20'
℄ TROY AVENUE
68+00
67+00
N 28°58'15" E
Riprap
Riprap
68" x 43" x 148' R.C.P.
20'
Slope Trans
10'
5'
5'
3:1
3:1
2:1
℄ = 10'

Courtesy of Colorado Department of Highways.

Geologic Map


Newburg
Altoona Reservoir
Mill Run
Bellwood
Obs
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Williamsburg
Robeson Extension
McConnell
Hollidaysburg
Duncansville
Dbh
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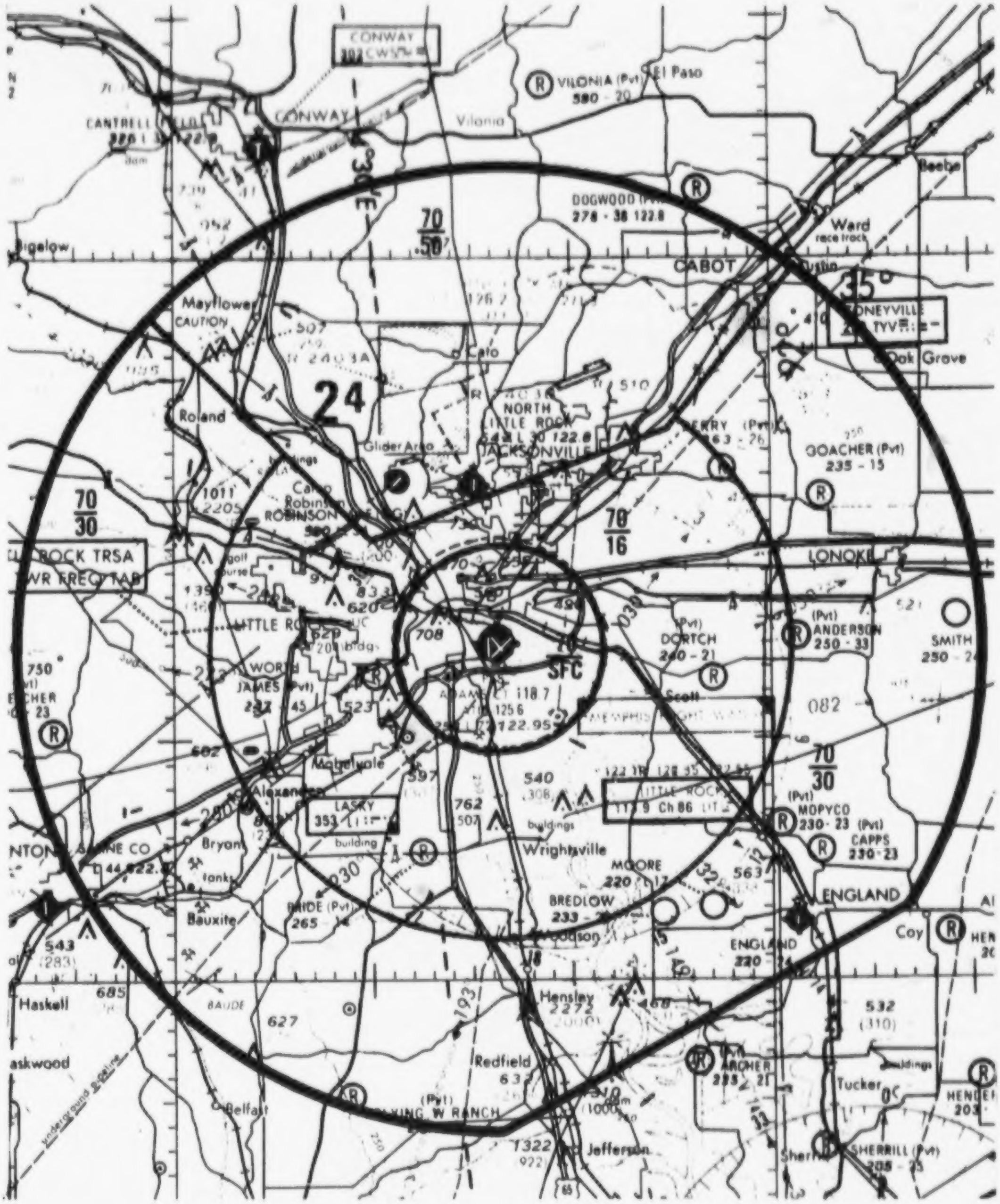
Dh
Swc
Sbm
Frankstown Branch
East Freedom
Roaring Spring
East Sharpsburg
Or
Ocl
Oj
Martinsburg
Clover Creek
Ons
Curryville
Henrietta
Entriken
Mp
Great Trough Cr
Newburg
Mmc
Pp
Pa
Dudley
Broad Top City
Robertsdale
Coaldale
Cooks
Df
Dl
DSkt
New Enterprise
Waterside
Woodbury

Aeronautical Chart


CONWAY
CONWAY
CANTRELL FIELD
VILONIA (Pvt)
580 - 20
El Paso
Vilonia
Beebe
DOGWOOD (Pvt)
278 - 38 122.8
Ward
race track
CABOT
Austin
35°
JONEYVILLE
TYV
Oak Grove
Bigelow
Mayflower
CAUTION
70
50
24
Cato
NORTH LITTLE ROCK
JACKSONVILLE
Glider Area
Roland
FERRY (Pvt)
263 - 26
GOACHER (Pvt)
235 - 15
Camp Robinson
ROBINSON
70
30
70
16
LITTLE ROCK TRSA
TWR FREQ TAB
LONOKE
golf course
LITTLE ROCK
708
SFC
DORTCH
240 - 21
(Pvt)
ANDERSON
250 - 33
SMITH
Scott
082
WORTH JAMES (Pvt)
ADAMS
CT 118.7
ATIS 125.6
122.95
MEMPHIS
750
523
602
Mabelvale
Alexander
597
540
762
LITTLE ROCK
113.9 Ch 86 LIT
70
30
(Pvt)
MOPYCO
230 - 23
(Pvt)
CAPPS
230 - 23
LASKY
353
building
buildings
Wrightsville
Bryant
SALINE CO
tanks
MOORE
220
563
ENGLAND
Bauxite
BRIDE (Pvt)
265
BREDLOW
233
Dodson
ENGLAND
220
Coy
543
(283)
Haskell
685
BAUDE
627
193
Hensley
2272
(2000)
532
(310)
askwood
Redfield
633
ARCHER
233 - 21
Tucker
buildings
underground pipeline
Belfast
(Pvt)
KING W RANCH
1322
(922)
Jefferson
Sherrill
SHERRILL (Pvt)
205 - 23

Kinds of Surveying and Mapping

Land or Property Surveying (Cadastral)
- Property and boundary surveys
- Subdivision surveys and plats
- Public-lands surveys
- Surveys for plans and plats

Engineering Surveys for Design and Construction
- Design data surveys (including route surveys)
- Construction surveys
- Mine surveys

Geodetic Surveying, Geodetic Engineering, or Geodesy
- Control surveys, first- and second-order accuracy
- Geodetic astronomy
- Gravity surveys, magnetic declination surveys, figure-of-the-earth studies

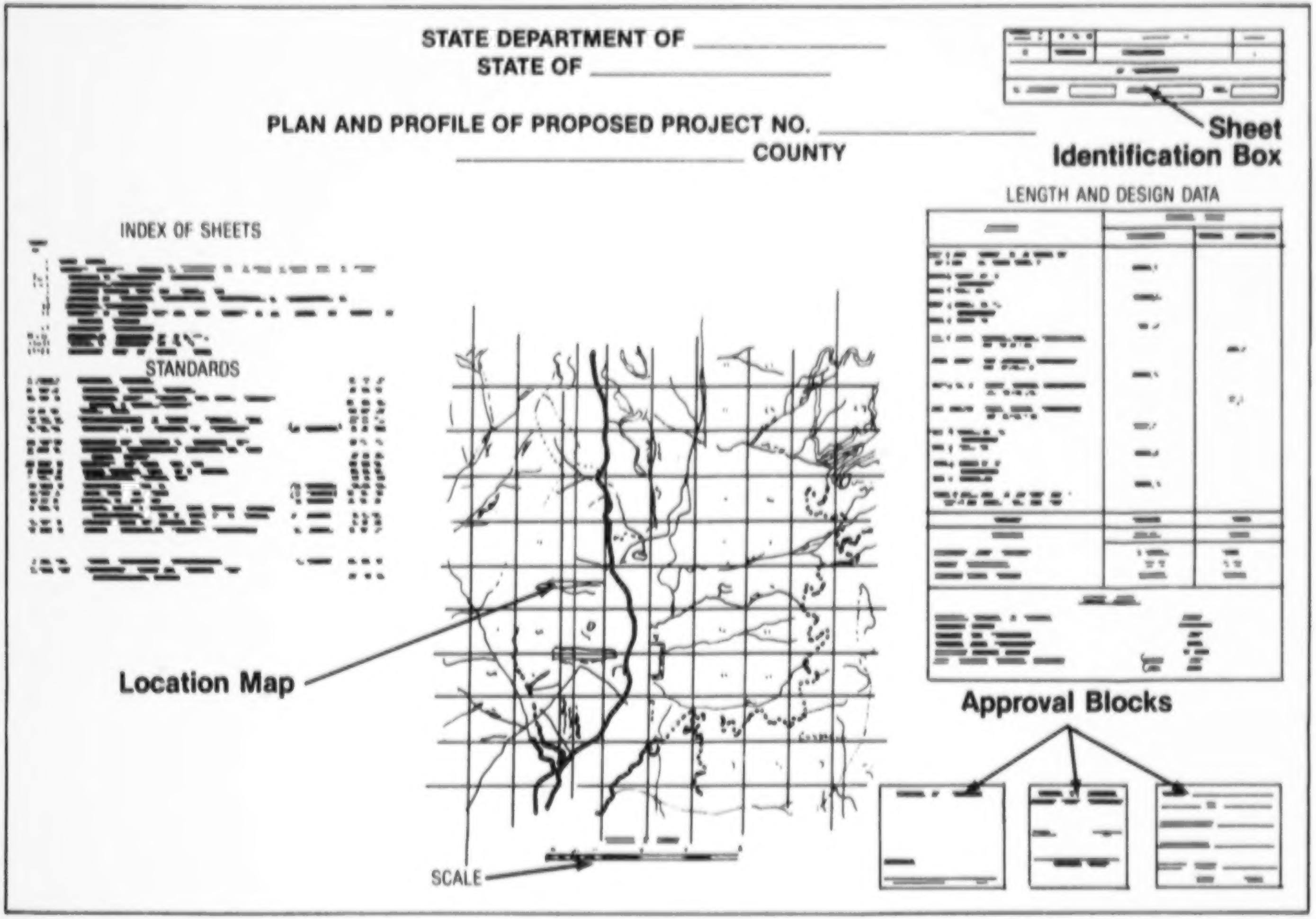
Cartographic Surveying, Cartographic Engineering, or Map and Chart Surveying
- Control surveys, third- and fourth-order accuracy
- Topographic-planimetric surveys and maps
- Hydrographic surveys

Aerial Survey Series
- Aerial photography
- Electrical measurements for distances and position fixes
- Airborne magnetometer surveys
- Radar-altimeter profiles and elevation

Cartography (Not Requiring Original Surveys)
- Map design
- Compilation derived from existing source data
- Map editing
- Map reproduction

From *Mapping and Topographic Drafting* by John Bies and Robert Long. Reprinted with permission of South-Western Publishing Company.

Typical Title Sheet



STATE DEPARTMENT OF ______________

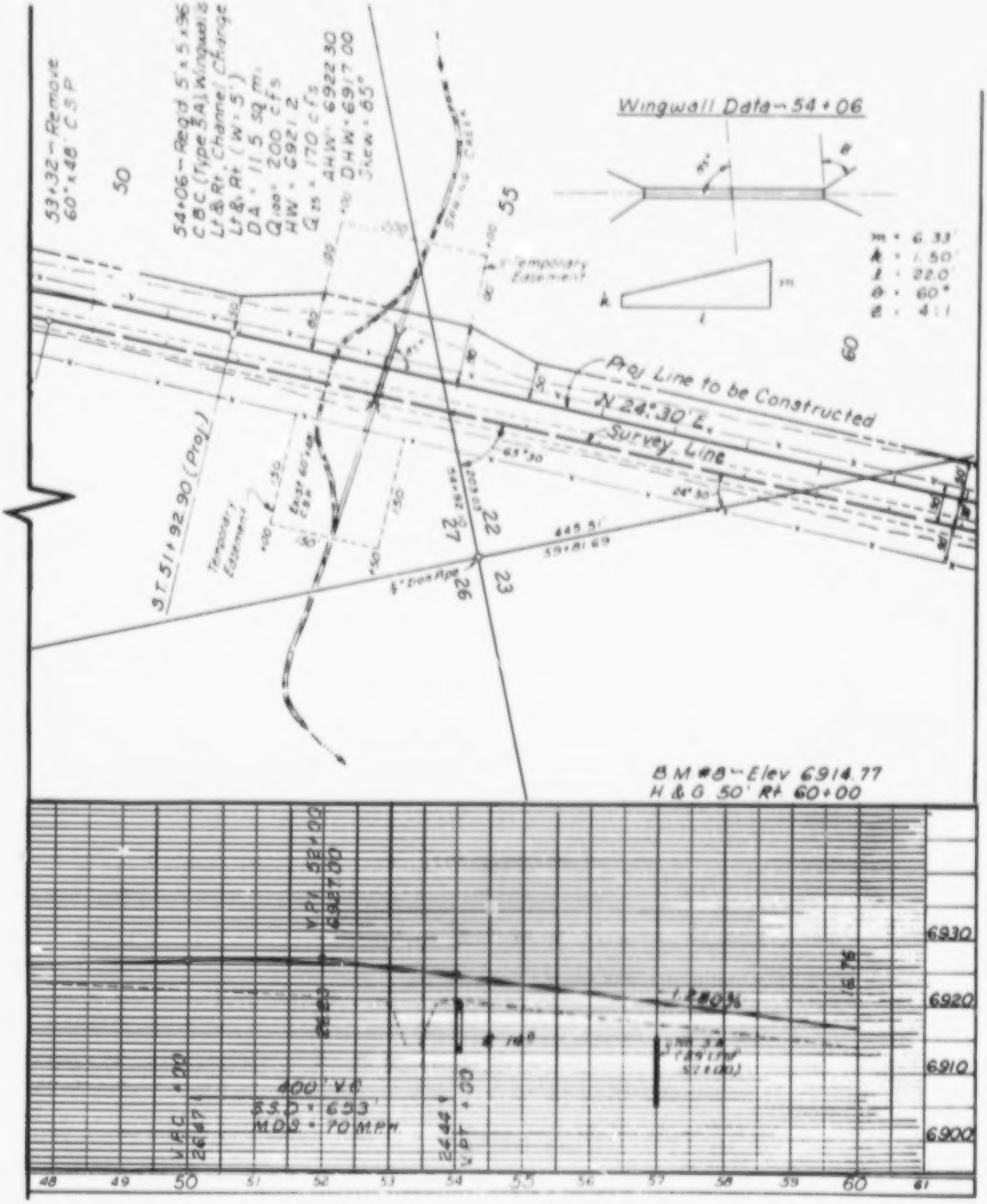
STATE OF ______________

PLAN AND PROFILE OF PROPOSED PROJECT NO. ______________

______________ COUNTY

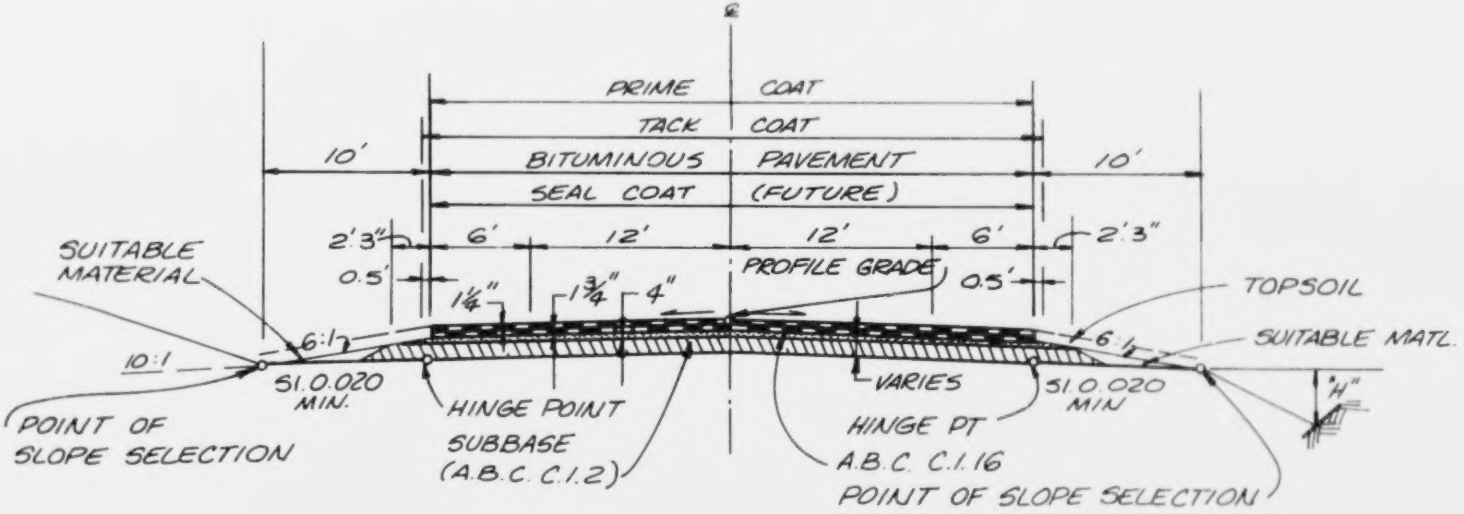
Sheet Identification Box
LENGTH AND DESIGN DATA
INDEX OF SHEETS
STANDARDS
Location Map
Approval Blocks
SCALE

Typical Plan and Profile


53+32 – Remove
60"x48" CSP
50
54+06 – Reqd 5'x5'x96
CBC (Type 5A) Wingwalls
Lt & Rt; Channel Change
Lt & Rt (W=5')
DA = 11.5 sq mi
Q100 = 200 cfs
HW = 6921.2
Q25 = 170 cfs
AHW = 6922.30
DHW = 6917.00
Skew = 65°
55
Temporary Easement
Wingwall Data – 54+06
m = 6.33'
k = 1.50'
l = 22.0'
θ = 60°
e = 4:1
60
Proj Line to be Constructed
N 24°30' E.
Survey Line
65°30
24°30
ST. 51+92.90 (Proj.)
Temporary Easement
27
22
26
23
445.51'
59+81.69
5/8" Iron Pipe
BM #8 – Elev 6914.77
H & G 50' Rt 60+00
V.P.I. 52+00
6927.00
V.P.C. 50+00
6926.47
400' VC
S.S.D. = 653'
M.D.S. = 70 M.P.H.
V.P.T. 54+00
6924.44
1.280%
16.76
6930
6920
6910
6900
48
49
50
51
52
53
54
55
56
57
58
59
60
61

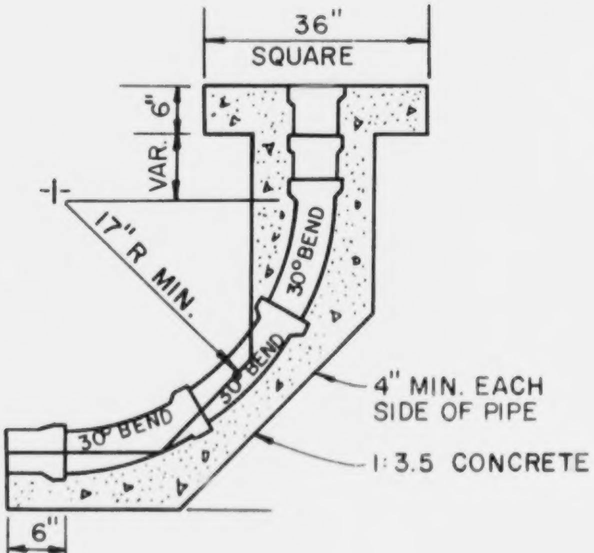
Courtesy of Colorado Department of Highways.

Typical Roadway Cross Section

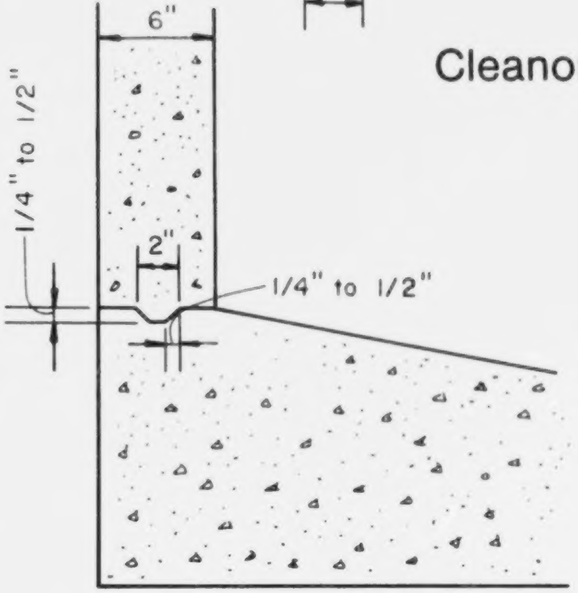

℄
PRIME COAT
TACK COAT
BITUMINOUS PAVEMENT
SEAL COAT (FUTURE)
10'
10'
2'3"
2'3"
6'
12'
12'
6'
0.5'
0.5'
PROFILE GRADE
SUITABLE MATERIAL
1¼"
1¾"
4"
TOPSOIL
SUITABLE MATL.
6:1
6:1
10:1
51.0.020 MIN.
51.0.020 MIN
VARIES
"H"
POINT OF SLOPE SELECTION
HINGE POINT
SUBBASE (A.B.C. C.1.2)
HINGE PT
A.B.C. C.1.16
POINT OF SLOPE SELECTION

Courtesy of Colorado Department of Highways.

Typical Structural Details

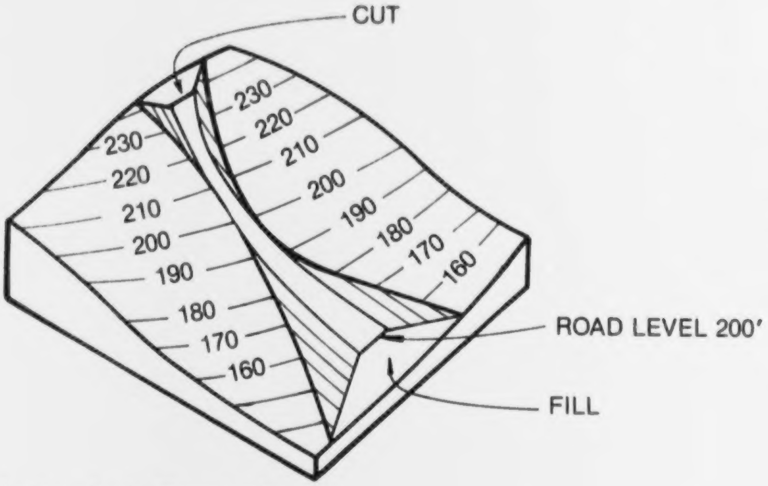

36"
SQUARE
6"
VAR.
17" R MIN.
30° BEND
30° BEND
30° BEND
4" MIN. EACH SIDE OF PIPE
1:3.5 CONCRETE
6"

Cleanout Detail

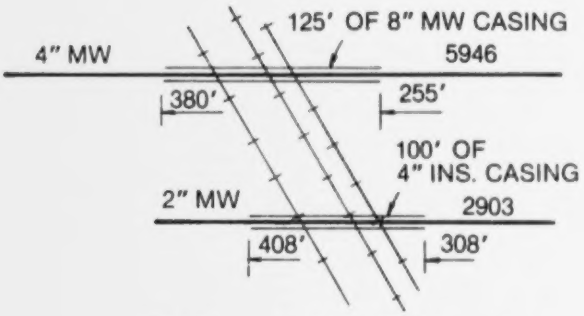

6"
1/4" to 1/2"
2"
1/4" to 1/2"

Detail: Key Construction Joint for Bottom and Walls

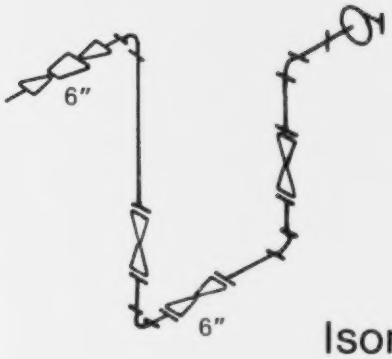
Other Civil Drawings


CUT
230
220
210
200
190
180
170
160
230
220
210
200
190
180
170
160
ROAD LEVEL 200'
FILL

Pictorial Drawing

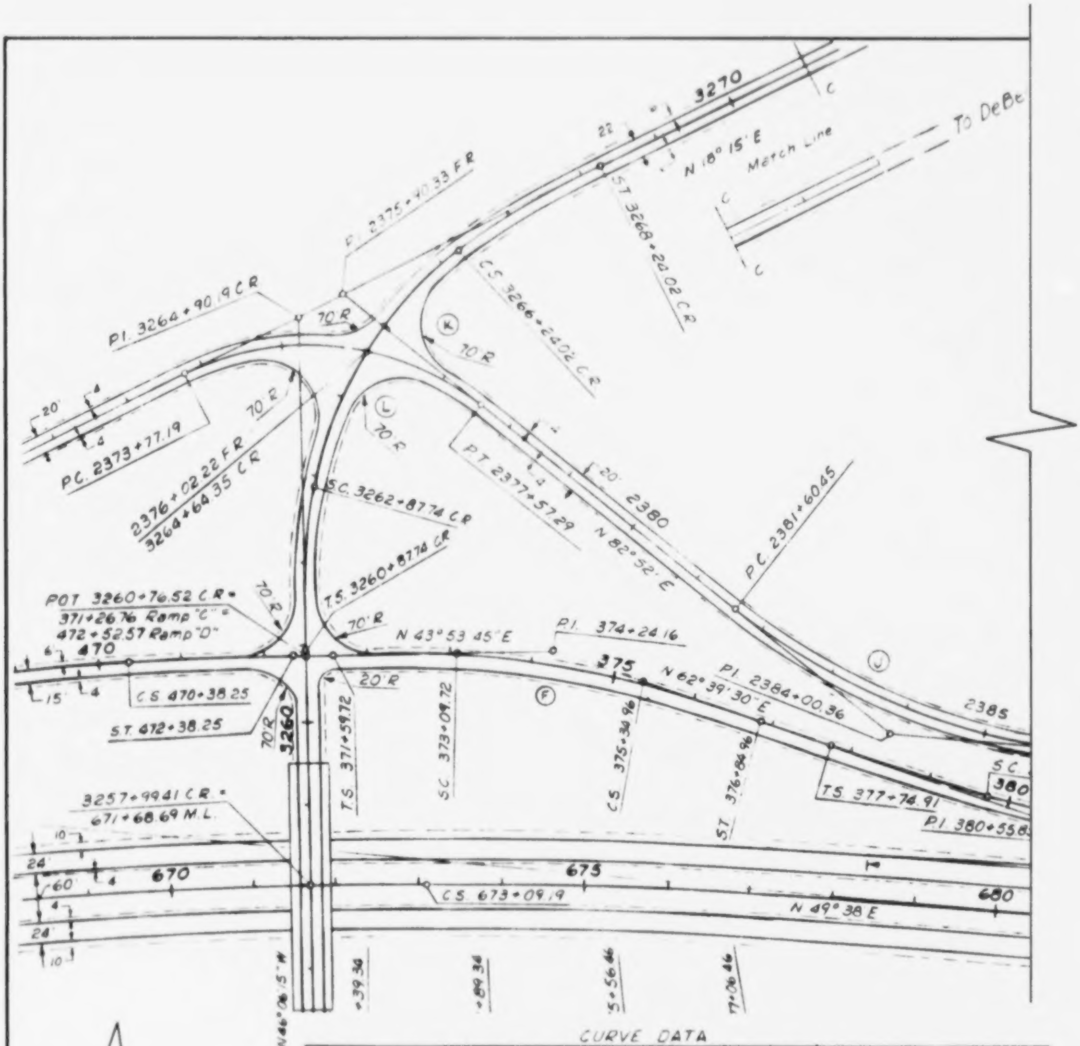

125' OF 8" MW CASING
4" MW
5946
380'
255'
100' OF
4" INS. CASING
2" MW
2903
408'
308'

Schematic Diagram



Isometric Diagram

Typical Intersection Detail

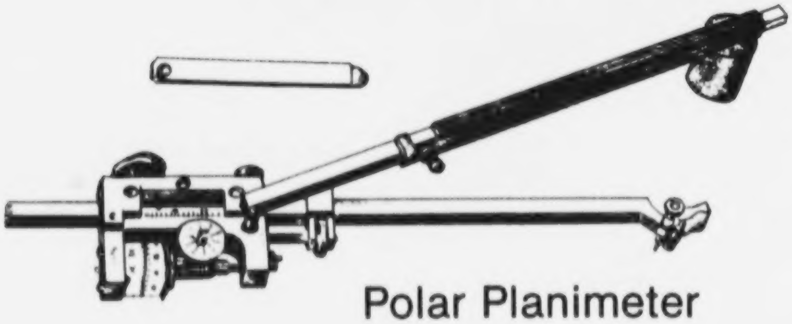

3270
C
22
N 18° 15' E
Match Line
To DeBe
C
C
P.I. 2375+40.33 F.R.
S.T. 3268+24.02 C.R.
C.S. 3266+24.02 C.R.
P.I. 3264+90.19 C.R.
70' R
K
70' R
20'
4
4
P.C. 2373+77.19
70' R
2376+02.22 F.R. = 3264+64.35 C.R.
L
70' R
P.T. 2377+57.29
20'
2380
N 82° 52' E
S.C. 3262+87.74 C.R.
T.S. 3260+87.74 C.R.
P.C. 2381+60.45
P.O.T. 3260+76.52 C.R. = 371+26.76 Ramp "C" = 472+52.57 Ramp "D"
70' R
70' R
N 43° 53' 45" E
P.I. 374+24.16
375
N 62° 39' 30" E
P.I. 2384+00.36
J
2385
470
15'
4
C.S. 470+38.25
S.T. 472+38.25
20' R
F
70' R
3260
T.S. 371+59.72
S.C. 373+09.72
C.S. 375+34.96
S.T. 376+84.96
T.S. 377+74.91
S.C.
380
P.I. 380+55.8
3257+99.41 C.R. = 671+68.69 M.L.
10'
24'
60'
4
670
675
C.S. 673+09.19
N 49° 38' E
680
4
24'
10'
N46°06'15"W
+39.34
+89.34
5+56.46
77+06.46

CURVE DATA

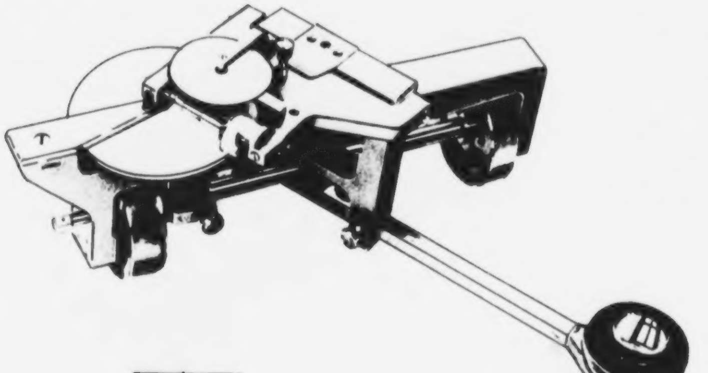
CURVE	Δ_s	T_s	Δ_c	D_c	L_c	R_c	θ_s	L_s	L.T	S.T	e				
A		372.98	18°29'15"	2°30'	739.48	2291.83					0.046%				
B	5°00'	200.10'	0°	2°30'	0'	2291.83	2°30	200'	33.35	66.68'	0.046%				
C	7°55'45"	233.86	4°10'45"	2°30'	167.2	2291.83	1°52'30"	150'	100.01	50.01'	0.046%				
D	13°39'45"	399.72	7°24'45"	2°30'	296.58	2291.83	3°07'30"	250'	166.69'	83.36'	0.046%				
E	4°01'30"	280.96	4°01'30"	2°30	161.03'	2291.83'	2°30	200'	133.35'	66.68	0.046%				
F	18°45'45"	264.44	11°15'45"	5°00'	225.25	1145.92	3°45'	150	100.02	50.02'	0.040%				
G	21°57'45	544.86	16°57'45"	2°30'	678.53	2291.83	2°30	200	133.35	66.68'	0.046%				
H		946.29	44°52'15"	2°30'	1794.80	2291.83					0.046%				
I		501.91	38°37'15"	4°00	965.52	1432.39					0.038%				
J		239.91	32°40'15"	7°00	466.75'	818.51'					0.020%				
K	64°21'15"	402.45	40°21'15"	12°00	336.28'	477.47	12°00'	200'	133.64	66.95'	0.020%				
L		213.14	64°37'0"	17°00	380.10'	337.33					0.020%				
M		212.08	47°56'0"	12°00	399.17	477.47'					0.020%				
N		242.66	55°57'30"	12°30	446.34'	458.37'					0.020%				

Courtesy of Colorado Department of Highways.

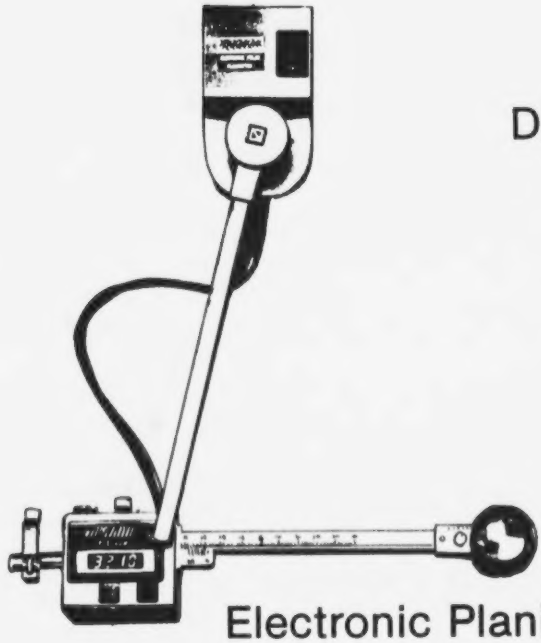
Planimeters



Polar Planimeter

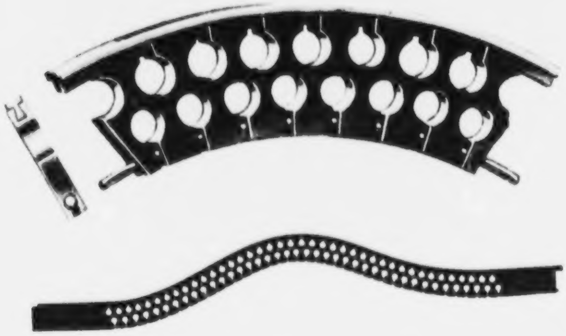


Disc Planimeter



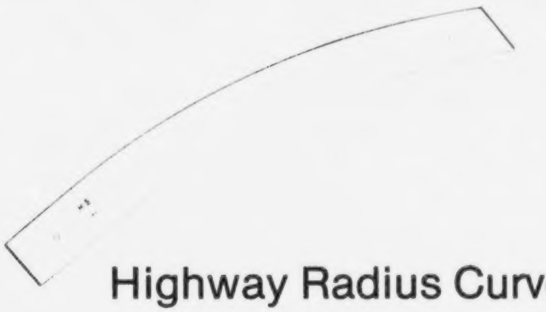
Electronic Planimeter

Types of Curves

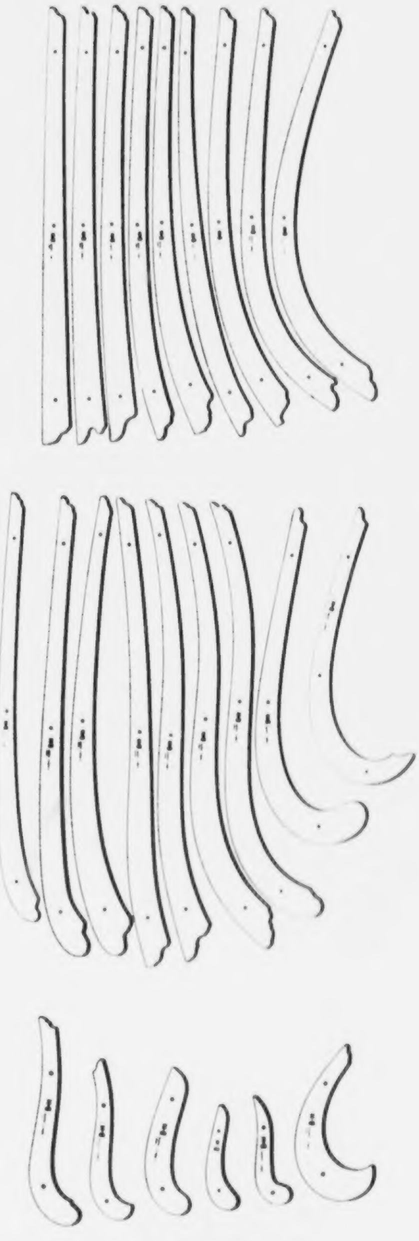


Flexible Curve Rules

Railroad Curve
(various degrees of curvature available)
0° 15′ — 20°

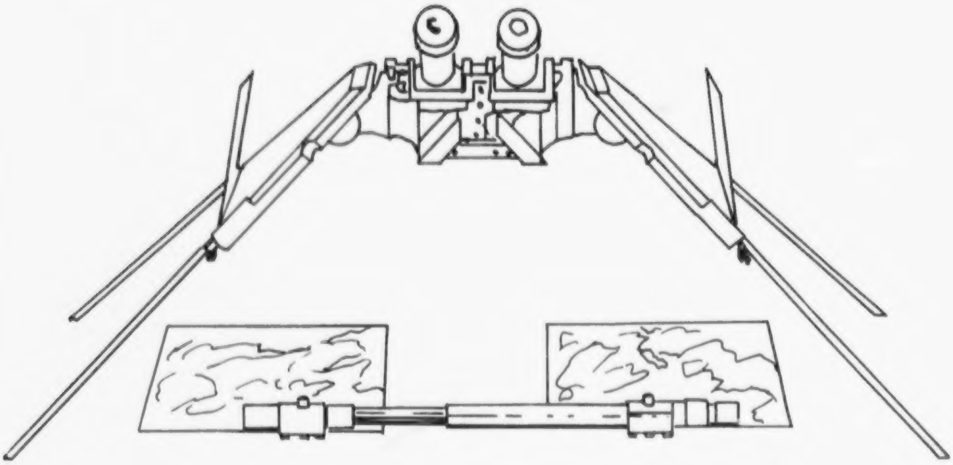


Highway Radius Curve
(various radii available)
3″ — 200″

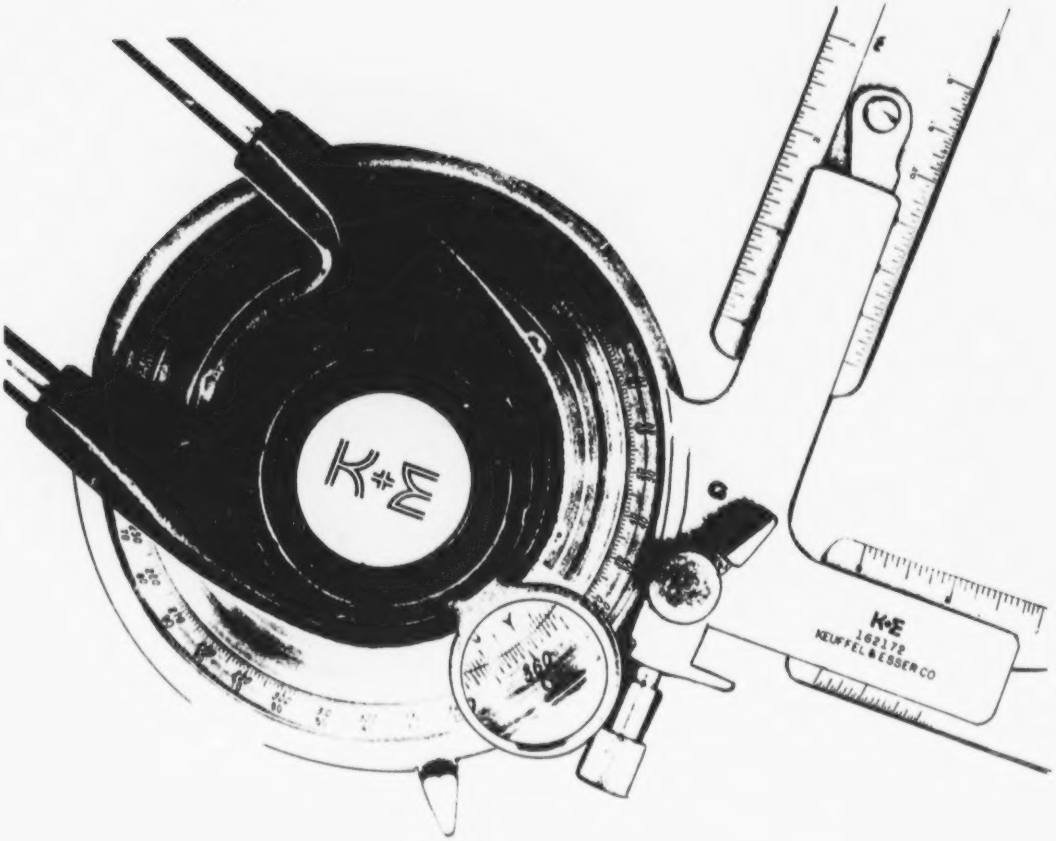


Ship Curves
(many patterns available)

Stereoscope

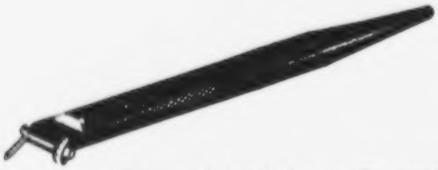


Civil Head Drafting Machine

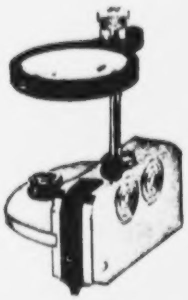

K+E
360
K+E
162179
KEUFFEL & ESSER CO

Rotating Head with Double Vernier

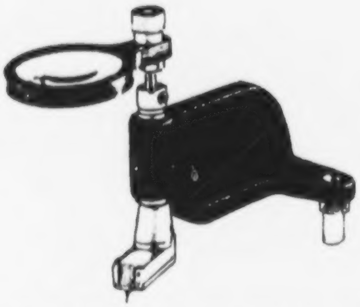
Scribing Tools



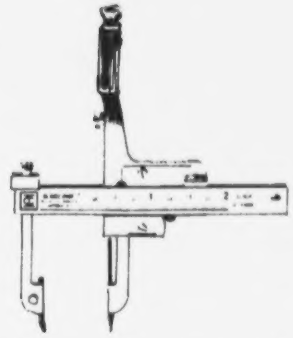
Pen Holder Scriber



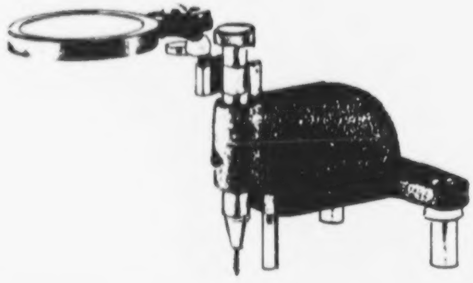
Straight Line Graver with Optic



Swivel Graver with Optic



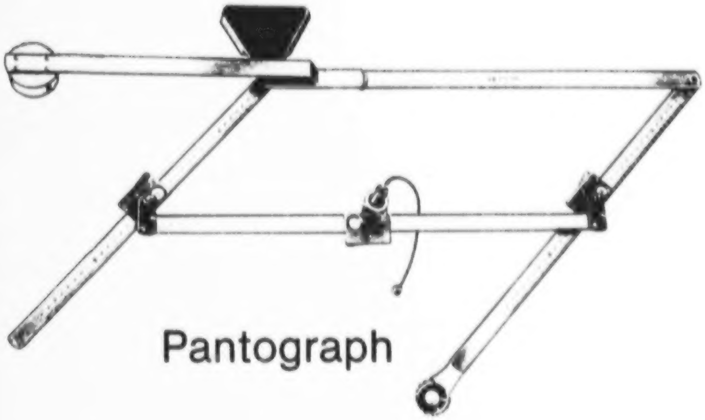
Direct Computing Compass



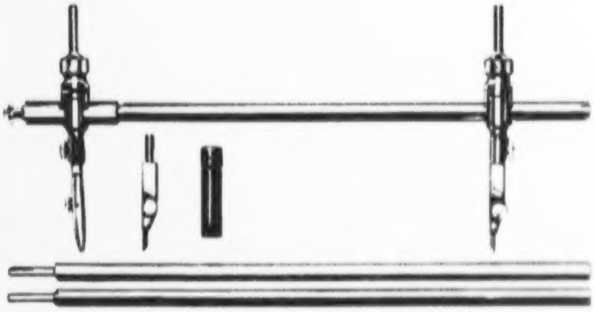
Rigid Graver with Optic

Courtesy of Keuffel and Esser Company.

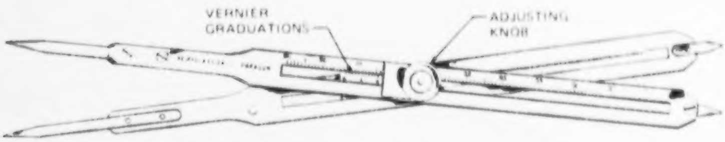
Other Specialty Tools



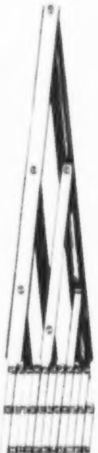
Pantograph



Beam Compass


VERNIER GRADUATIONS
ADJUSTING KNOB

Proportional Divider



Spacing Divider

Courtesy of Keuffel and Esser Company.

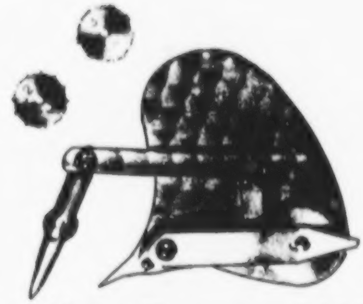
Other Specialty Tools

(Continued)

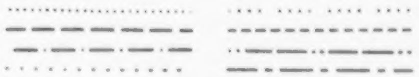
Map Measures

Minerva® Curvimeter

Courtesy of Keuffel and Esser Company.



Kern Dotting Pen and Wheels



Kern Dotting Patterns
(others available)

INTRODUCTION TO CIVIL DRAFTING
UNIT I

ASSIGNMENT SHEET #1 — TAKE BASIC MATH PRETEST

Directions: The following problems are designed to assess your basic math skills in various areas. Solve each problem and place your answer in the blank or space allowed.

PART A: Addition

1. $\begin{array}{r} 9 \\ +\ 8 \\ \hline \end{array}$

2. $\begin{array}{r} 8 \\ +\ 8 \\ \hline \end{array}$

3. $\begin{array}{r} 92 \\ 38 \\ +\ 77 \\ \hline \end{array}$

4. $\begin{array}{r} 87 \\ 26 \\ +\ 44 \\ \hline \end{array}$

5. $\begin{array}{r} 44 \\ 57 \\ +\ 63 \\ \hline \end{array}$

6. $\begin{array}{r} 923 \\ 934 \\ 966 \\ +\ 123 \\ \hline \end{array}$

7. $\begin{array}{r} 327 \\ 240 \\ 136 \\ +\ 238 \\ \hline \end{array}$

8. $\begin{array}{r} 270 \\ 368 \\ 609 \\ +\ 224 \\ \hline \end{array}$

9. If a crew works 320 hours one week, 416 hours the next week, 345 hours the third week, and 218 hours the fourth week, how many hours did the crew work in that month?

    ____________________ hours

10. While repairing surface failures, a crew laid 528 sq ft of aggregate on the first job, 640 sq ft on the second job, and 580 sq ft on the third job. How many square feet did the crew cover?

    ____________________ sq ft

PART B: Subtraction

1. $\begin{array}{r} 84 \\ -\ 57 \\ \hline \end{array}$

2. $\begin{array}{r} 4635 \\ -\ 3187 \\ \hline \end{array}$

3. $\begin{array}{r} 4178 \\ -\ 1539 \\ \hline \end{array}$

4. $\begin{array}{r} 983 \\ -\ 656 \\ \hline \end{array}$

5. $\begin{array}{r} 771 \\ -\ 289 \\ \hline \end{array}$

6. $\begin{array}{r} 53 \\ -\ 39 \\ \hline \end{array}$

7. $\begin{array}{r} 356 \\ -\ 178 \\ \hline \end{array}$

8. $\begin{array}{r} 378 \\ -\ 179 \\ \hline \end{array}$

ASSIGNMENT SHEET #1

9. If the boom on a side boom is 18 ft and you need 25 ft to do a particular job, how much boom would have to be added?

_____________________ ft

10. If guardrails were placed along 2,488 linear ft of roadway the first day, and the operator needed to place them along 8,562 linear ft that week, how much more distance would have to be covered in the remaining four days?

_____________________ linear ft

PART C: Multiplication

1. $\begin{array}{r} 63 \\ \times\ 38 \\ \hline \end{array}$
2. $\begin{array}{r} 85 \\ \times\ 76 \\ \hline \end{array}$
3. $\begin{array}{r} 32 \\ \times\ 59 \\ \hline \end{array}$
4. $\begin{array}{r} 42 \\ \times\ 96 \\ \hline \end{array}$
5. $\begin{array}{r} 73 \\ \times\ 64 \\ \hline \end{array}$
6. $\begin{array}{r} 54 \\ \times\ 83 \\ \hline \end{array}$
7. $\begin{array}{r} 567 \\ \times\ 485 \\ \hline \end{array}$
8. $\begin{array}{r} 879 \\ \times\ 729 \\ \hline \end{array}$

9. If a load of fill weighs 18,796 lb, how much would 78 loads weigh?

_____________________ pounds

10. If a dragline could stockpile 676 cubic yd of dirt in two days, how much could be stockpiled in 14 days?

_____________________ cubic yards

PART D: Division

1. $8\overline{)96}$
2. $12\overline{)24}$
3. $30\overline{)90}$
4. $66\overline{)198}$

ASSIGNMENT SHEET #1

5. $15\overline{)60}$　　6. $23\overline{)276}$　　7. $19\overline{)152}$　　8. $62\overline{)7739}$

9. If a forklift travels 4,572 miles a year, how far would it travel in one month?

    ____________________ miles

10. If the distance across a ravine is 13,608 ft, and the equipment can move only 90 ft. per day, how long would it take for the equipment to cross?

    ____________________ days

PART E: Converting fractions

1. Convert each of the following mixed numbers to improper fractions (where the numeration is the same or larger than the denominator such as 4/4, 5/3, and 10/9.) **Do not** reduce answers to lowest terms at this time.

    a. $3\frac{1}{4}$ = ______

    b. $4\frac{1}{2}$ = ______

    c. $7\frac{1}{3}$ = ______

    d. $8\frac{1}{2}$ = ______

    e. $6\frac{2}{3}$ = ______

    f. $2\frac{1}{2}$ = ______

    g. $3\frac{2}{4}$ = ______

    h. $7\frac{3}{4}$ = ______

    i. $9\frac{2}{3}$ = ______

    j. $5\frac{2}{3}$ = ______

ASSIGNMENT SHEET #1

2. Convert each of the following improper fractions to mixed numbers. **Do not** reduce answers to lowest terms at this time.

a. $\frac{16}{5}$ = ______

b. $\frac{12}{5}$ = ______

c. $\frac{17}{3}$ = ______

d. $\frac{8}{3}$ = ______

e. $\frac{9}{2}$ = ______

f. $\frac{19}{13}$ = ______

g. $\frac{8}{7}$ = ______

h. $\frac{75}{32}$ = ______

i. $\frac{24}{17}$ = ______

j. $\frac{13}{9}$ = ______

PART F: Reducing fractions to lowest terms

Reduce the following fractions to the lowest terms.

1. $\frac{3}{9}$ = ______

2. $\frac{8}{24}$ = ______

3. $\frac{10}{15}$ = ______

4. $\frac{15}{25}$ = ______

5. $\frac{12}{48}$ = ______

6. $\frac{5}{5}$ = ______

7. $\frac{8}{12}$ = ______

8. $\frac{7}{21}$ = ______

9. $\frac{4}{8}$ = ______

10. $\frac{10}{12}$ = ______

ASSIGNMENT SHEET #1

PART G: Finding lowest common denominators (LCD)

Find the lowest common denominator and convert each fraction to its LCD equivalent.

1. a. $\frac{2}{3}, \frac{7}{9}$ LCD = ____

   b. $\frac{2}{3}$ = ____

   c. $\frac{7}{9}$ = ____

2. a. $\frac{7}{8}, \frac{5}{6}$ LCD = ____

   b. $\frac{7}{8}$ = ____

   c. $\frac{5}{6}$ = ____

3. a. $\frac{1}{3}, \frac{11}{12}, \frac{3}{8}$ LCD = ____

   b. $\frac{1}{3}$ = ____

   c. $\frac{11}{12}$ = ____

   d. $\frac{3}{8}$ = ____

4. a. $\frac{1}{7}, \frac{5}{8}$ LCD = ____

   b. $\frac{1}{7}$ = ____

   c. $\frac{5}{8}$ = ____

5. a. $\frac{1}{16}, \frac{3}{8}, \frac{3}{4}$ LCD = ____

   b. $\frac{1}{16}$ = ____

   c. $\frac{3}{8}$ = ____

   d. $\frac{3}{4}$ = ____

ASSIGNMENT SHEET #1

PART H: Adding, subtracting, multiplying, and dividing fractions

1. $\frac{7}{12} + \frac{5}{8} =$ ______

2. $\frac{3}{5} + \frac{2}{3} =$ ______

3. $\frac{1}{16} + \frac{3}{8} + \frac{3}{4} =$ ______

4. $\frac{3}{20} + \frac{3}{4} + \frac{7}{10} + \frac{4}{5} =$ ______

5. $\frac{7}{8} - \frac{2}{3} =$ ______

6. $\frac{4}{5} - \frac{3}{8} =$ ______

7. $\frac{5}{9} - \frac{3}{8} =$ ______

8. $\frac{1}{3} - \frac{5}{16} =$ ______

9. $1\frac{1}{2} \times 2\frac{1}{4} =$ ______

10. $\frac{1}{2} \times 6\frac{1}{2} =$ ______

11. $\frac{7}{8} \times \frac{2}{3} =$ ______

12. $\frac{1}{4} \times \frac{1}{3} \times \frac{1}{2} =$ ______

13. $\frac{3}{8} \div \frac{1}{2} =$ ______

14. $8 \div \frac{3}{5} =$ ______

15. $12\frac{3}{8} \div 1\frac{1}{2} =$ ______

ASSIGNMENT SHEET #1

PART I: Converting fractions to decimals

1. $5\frac{6}{10} =$ ______
2. $1\frac{2}{100} =$ ______
3. $\frac{87}{1000} =$ ______
4. $7\frac{83}{1000} =$ ______
5. $5\frac{6}{100} =$ ______
6. $3\frac{3}{4} =$ ______
7. $55\frac{1}{2} =$ ______
8. $110\frac{5}{8} =$ ______
9. $77\frac{1}{50} =$ ______
10. $12\frac{2}{3} =$ ______

PART J: Adding, subtracting, multiplying, and dividing decimals

1. $$\begin{array}{r} 5.29 \\ 4.38 \\ +\ 9.62 \\ \hline \end{array}$$

2. $$\begin{array}{r} 72.24 \\ 16.38 \\ +\ 92.37 \\ \hline \end{array}$$

3. 868.87 − 516.89 = ______________
4. \$15 − \$12.53 = ________________
5. 2.54 × 3.1 = ___________________
6. 35 × 8.5 = _____________________
7. 120 × 0.33 = ___________________
8. 26.4 × 3.8 = ___________________
9. 10.71 ÷ 0.07 = _________________
10. 0.225 ÷ 0.15 = ________________

ASSIGNMENT SHEET #1

PART K: Converting fractions to percentages

1. $\frac{1}{4}$ = _____

2. $\frac{2}{9}$ = _____

3. $\frac{7}{10}$ = _____

4. $\frac{3}{4}$ = _____

5. $\frac{2}{2}$ = _____

PART L: Percentage problems

1. There are 100 bolts in a box. Twenty-five bolts are what percent of the bolts in the box?

   ____

2. If 11% of the students in a school are absent, what percent are present? __________

3. There are 20 students in a class. Sixty percent of the students are boys. How many are boys? ____________________

4. One day 5% of the 20 operators in Mr. Moore's group made perfect time completing a job. How many operators made perfect time? ____________________

5. Contractor McGill bought a new compressor, regularly selling for $120, at a sale and saved 20%. What was the sale price? ____________________

PART M: Mix ratio problems

1. Given 90 cu yd of aggregate, how much sand will you need to mix a 3:2 ratio of sand and aggregate?

   ____________________ cu yd of sand

2. You are to mix ¼" aggregate and ½" aggregate to a ratio of 3:2. How much ¼" aggregate will you need if you have 150 cu yd of ½" aggregate?

   ____________________ cu yd of ¼" aggregate

3. Given 300 gallons of asphalt concrete, mix asphalt concrete and solvent to a ratio of 75:25. How much solvent will you need?

   ____________________ gal of solvent

ASSIGNMENT SHEET #1

4. The fuel mixture ratio of gasoline to two-cycle engine oil is 20:1 for your chain saw. How much oil will you add to 5 gal of gas?

    ____________________ qt of oil

5. The ratio of an industrial strength cleaner in water is 6 parts cleaner to 100 parts water. You estimate the job will take 15 gallons of water. How much cleaner will you add?

    ____________________ gal cleaner

PART N: Slope ratio problems

1. Find the slope ratio in feet and in inches. Convert distances to like terms where needed. Round off to the nearest hundredth.

    V = vertical distance

    H = horizontal distance

	DISTANCES	RATIO (FEET)	RATIO (INCHES)	SLOPE RATIO
a.	V = 12 ft, H = 24 ft	______	______	______
b.	H = 15 in, V = 5 in	______	______	______
c.	H = 5 ft, V = 0.05 ft	______	______	______
d.	V = 1 in, H = 3 ft	______	______	______
e.	H = 12 ft, V = 4 in	______	______	______

2. Find the vertical distance.

	SLOPE RATIO	HORIZONTAL DISTANCE	VERTICAL DISTANCE
a.	3:1	24 ft	______ ft
b.	14:1	224 in	______ in

3. Find the horizontal distance.

	SLOPE RATIO	VERTICAL DISTANCE	HORIZONTAL DISTANCE
a.	25:1	0.5 ft	______ ft
b.	16:3	9 in	______ ft
c.	40:1	4 ft	______ ft

ASSIGNMENT SHEET #1

PART O: Measure and volume

1. Conversions. Round answers to nearest tenth.

   a. 48 in = __________ ft

   b. 312 ft = __________ yd

   c. 8 cu yd = __________ cu ft

   d. 7 sq yd = __________ sq ft

   e. 11 gal = __________ qt

2. Basic formulas for areas and volumes

   a. 24′ long, 18′ wide — Surface area =__________

   b. 13″ wide, 2 ½″ long — Surface area = __________

   c. 7′ long, 2′ wide, 1′ high — Volume =__________

   d. ½′ wide, 3″ high, 2′ long — Volume =__________

   e. 4″ long, 2″ wide, ½″ high — Volume = __________

3. Word problems. Round off answers to the nearest tenth. Show your work.

   a. One cubic yard of aggregate weighs 2,550 lb. How many tons would 10 cubic yards weigh?

      (NOTE: 1 ton = 2,000 lb)

      __________ tons

   b. What is the surface area of a failure 2 ft 8 in by 1 ft 6 in?

      __________ sq ft

ASSIGNMENT SHEET #1

c. How many cubic feet of concrete will be required to make a pavement patch 8 feet long, 7 feet wide and 6 inches deep?

_____________ cu ft

d. How many square feet have to be painted on a building 20 feet long on each side and 14 feet high if you paint all four sides? If a gallon of paint covers 350 square feet, how many gallons are required?

_____________ sq ft _____________ gal of paint

INTRODUCTION TO CIVIL DRAFTING
UNIT I

ASSIGNMENT SHEET #2 — INTERVIEW A CIVIL DRAFTER

Directions: Make an appointment with a civil drafter who is presently employed in that capacity. Ask the following questions and record the answers in the blanks provided.

1. What is your career title?
2. What tasks do you perform on the job?
3. What educational training and occupational experience is required for this job?
4. What personality traits are most important in your field?
5. What skills and knowledge are required in this occupation?
6. What is the approximate starting salary of workers in your occupation?
7. What is the employment outlook for the future in this career?

ASSIGNMENT SHEET #2

8. What are the possibilities for advancement in this field?

9. What is your favorite part of this job?

10. What is your least favorite part of the job?

INTRODUCTION TO CIVIL DRAFTING
UNIT I

ASSIGNMENT SHEET #3 — RESEARCH THE POSSIBLE EMPLOYMENT OPPORTUNITIES IN CIVIL DRAFTING IN YOUR LOCAL AREA

1. List the names of firms in your area that may employ civil drafters.

   (NOTE: Include address and phone numbers for future reference.)

FIRM	ADDRESS	PHONE #

2. Inquire at each of these firms if they employ civil drafters and if they will be hiring in the near future. If a firm is currently not hiring, ask how they go about filling openings (newspaper ads, job placement at your school, employment agency, etc.)

FIRM	OPENINGS	HIRING PROCEDURE

ASSIGNMENT SHEET #3

3. Make a list of local, county, and state agencies that hire civil drafters.

AGENCY	ADDRESS

4. Find out what federal agencies in your area hire civil map drafters.

AGENCY	ADDRESS

5. Look in the major local paper and clip out any ads for civil drafters. (Attach to this assignment sheet.)

ASSIGNMENT SHEET #3

6. Look in your local phone directory for any private consulting engineers and list below.

(NOTE: Many consulting firms hire civil drafters on a contract basis.)

____

____

____

____

____

____

INTRODUCTION TO CIVIL DRAFTING
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART A

1. 17
2. 16
3. 207
4. 157
5. 164
6. 2946
7. 941
8. 1471
9. 1,299 hours
10. 1,748 sq ft

PART B

1. 27
2. 1448
3. 2639
4. 327
5. 482
6. 14
7. 178
8. 199
9. 7 feet
10. 6,084 linear feet

PART C

1. 2394
2. 6460
3. 1888
4. 4032
5. 4672
6. 4482
7. 274,995
8. 640,791
9. 1,466,088 pounds
10. 4,732 cubic yards

ANSWERS TO ASSIGNMENT SHEETS

PART D

1. 12
2. 2
3. 3
4. 3
5. 4
6. 12
7. 8
8. 124, R51
9. 381 miles
10. 151.2 days

PART E

1. a. $^{13}/_{4}$
   b. $^{9}/_{2}$
   c. $^{22}/_{3}$
   d. $^{17}/_{2}$
   e. $^{20}/_{3}$
   f. $^{5}/_{2}$
   g. $^{14}/_{4}$
   h. $^{31}/_{4}$
   i. $^{29}/_{3}$
   j. $^{17}/_{3}$

2. a. $3\ ^{1}/_{5}$
   b. $2\ ^{2}/_{5}$
   c. $5\ ^{2}/_{3}$
   d. $2\ ^{2}/_{3}$
   e. $4\ ^{1}/_{2}$
   f. $1\ ^{6}/_{13}$
   g. $1\ ^{1}/_{7}$
   h. $2\ ^{11}/_{32}$
   i. $1\ ^{7}/_{17}$
   j. $1\ ^{4}/_{9}$

PART F

1. $^{1}/_{3}$
2. $^{1}/_{3}$
3. $^{2}/_{3}$
4. $^{3}/_{5}$
5. $^{1}/_{4}$
6. 1
7. $^{2}/_{3}$
8. $^{1}/_{3}$
9. $^{1}/_{2}$
10. $^{5}/_{6}$

PART G

1. a. 9
   b. $^{6}/_{9}$
   c. $^{7}/_{9}$

2. a. 24
   b. $^{21}/_{24}$
   c. $^{20}/_{24}$

3. a. 24
   b. $^{8}/_{24}$
   c. $^{22}/_{24}$
   d. $^{9}/_{24}$

4. a. 56
   b. $^{8}/_{56}$
   c. $^{35}/_{56}$

5. a. 16
   b. $^{1}/_{16}$
   c. $^{6}/_{16}$
   d. $^{12}/_{16}$

ANSWERS TO ASSIGNMENT SHEETS

PART H

1. 1 5/24
2. 1 4/15
3. 1 3/16
4. 2 2/5
5. 5/24
6. 17/40
7. 13/72
8. 1/48
9. 3 3/8
10. 3 1/4
11. 7/12
12. 1/24
13. 3/4
14. 13 1/3
15. 8 1/4

PART I

1. 5.6
2. 1.02
3. .087
4. 7.083
5. 5.06
6. 3.75
7. 55.5
8. 110.625
9. 77.02
10. 12.667

PART J

1. 19.29
2. 180.99
3. 351.98
4. $2.47
5. 7.874
6. 297.5
7. 39.6
8. 100.32
9. 153
10. 1.5

PART K

1. 25%
2. 22.2%
3. 70%
4. 75%
5. 100%

ANSWERS TO ASSIGNMENT SHEETS

PART L

1. 25%
2. 89%
3. 12
4. 1
5. $96.00

PART M

1. 135 cu yd of sand
2. 225 cu yd of $^{1}/_{4}$" aggregate
3. 100 gal of solvent
4. 1 qt of oil
5. 0.9 gal cleaner

PART N

1.		RATIO (FEET)	RATIO (INCHES)	SLOPE RATIO
	a.	24:12	— —	2:1
	b.	— —	15:5	3:1
	c.	5:0.05	60:0.6	100:1
	d.	3:0.08	36:1	36:1
	e.	12:0.33	144:4	36:1

2. a. 8 ft
   b. 16 in

3. a. 12.5 ft
   b. 4 ft
   c. 160 ft

PART O

1. a. 4 ft
   b. 104 yd
   c. 216 cu ft
   d. 63 sq ft
   e. 44 qt

2. a. 432 sq ft
   b. 390 sq in
   c. 14 cu ft
   d. 432 cu in
   e. 4 cu in

ANSWERS TO ASSIGNMENT SHEETS

3. a. 12.8 tons
   b. 4 sq ft
   c. 28 cu ft
   d. 1120 sq ft, 3.2 gal of paint

Assignment Sheets #2 and #3 — Evaluated to the satisfaction of the instructor

INTRODUCTION TO CIVIL DRAFTING
UNIT I

NAME ________________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. Signifying basic relationship to the earth considered as a globe-shaped body; applies to data based on the geoid and on the spheroid

_____b. An optical instrument used for viewing two properly related photographs or diagrams simultaneously to obtain the impression of a 3-dimensional object

_____c. A precise survey of considerable extent which takes into account the shape of the earth

_____d. Computer-aided drafting or design

_____e. An outline of a cross section of the earth

_____f. A drafter used to support civil engineering with the preparation of technical materials

_____g. Graphic representation of the earth's surface drawn to scale on a plane surface

_____h. United States Geological Survey

_____i. A person who has completed a minimum of 4 years of college and has specialized in civil-related engineering

_____j. Determining and representing accurately on paper the area of any portion of the earth's surface, the lengths and directions of the bounding lines, and the contour of the surface by taking linear and angular measurements and by applying the principles of geometry and trigonometry

1. CAD
2. Cadastral map
3. Cartography
4. Civil drafter
5. Civil engineer
6. Civil engineering
7. Contour line
8. Elevation
9. Geodetic survey
10. Geographic

TEST

______k. A device for measuring small areas by mechanical integration

______l. A discipline concerned with the design and construction of various municipal and state projects for the general public, such as bridges, roads, dams, canals, and pipe lines

______m. The configuration or shape of the land surface of any area

______n. The science of map making

______o. An instrument for copying maps and drawings at a predetermined reduction or enlargement

______p. A map showing the boundaries of subdivisions of land, with bearings, lengths, and areas of individual tracts, for purposes of describing and recording ownership

______q. A line used to connect points on a land surface that have the same elevation

______r. Altitude or height above sea level

______s. A view as seen from directly above the land

11. Map
12. Pantograph
13. Planimeter
14. Plan view
15. Profile
16. Stereoscope
17. Surveying
18. Topography
19. U.S.G.S.

2. Select from the following list the required skills of a civil drafter by placing an "X" in the appropriate blanks.

______a. CAD training

______b. Computer programming training

______c. Science skills up through physics

______d. Recognition of map symbols and abbreviations

TEST

______e. Basic drafting techniques in line work, lettering, and the use of tools and equipment

______f. Math skills up through trigonometry

______g. Public speaking skills

______h. Good communication skills

______i. Drafting applications and calculations for basic surveying

______j. Surveying skills

3. List four job responsibilities of a civil drafter.

a. ____

b. ____

c. ____

d. ____

4. List three major employment opportunities for a civil drafter.

a. ____

b. ____

c. ____

5. Distinguish between organization structures for design teams in small and large firms by placing an "X" next to the descriptions of small firms.

______a. Communication is usually by word of mouth

______b. Usually have an organizational/standards manual which will include personnel policies and technical procedures

______c. Have specific lines of authority and responsibility

______d. The drafter will have many different job responsibilities

______e. Are able to specialize in a specific area of drafting or mapping

______f. Usually have ten or fewer staff members

______g. Are less structured

TEST

6. List seven specialty areas for civil engineering firms.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

7. Select from the following list the occupations related to civil drafting by placing an "X" in the appropriate blanks. Select only those that a civil drafter would be able to move into with minimal extra training.

_____a. Surveyor's helper

_____b. Instrument surveyor's assistant

_____c. Map maker

_____d. Surveyor

_____e. Topographic drafter

_____f. Pipe drafter

_____g. Civil engineer

_____h. City engineer

_____i. Civil engineering technician

_____j. Cartographic drafter

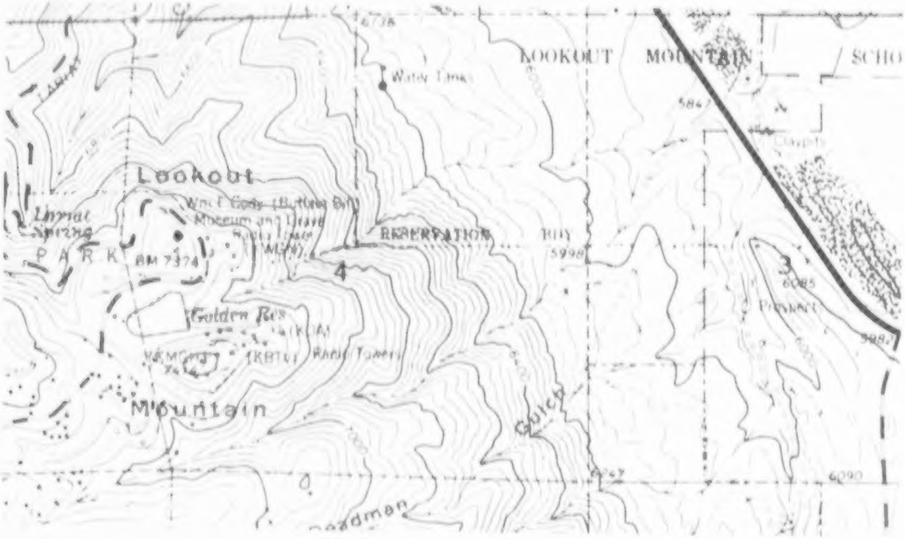
_____k. Electronic drafter

_____l. Traffic technician

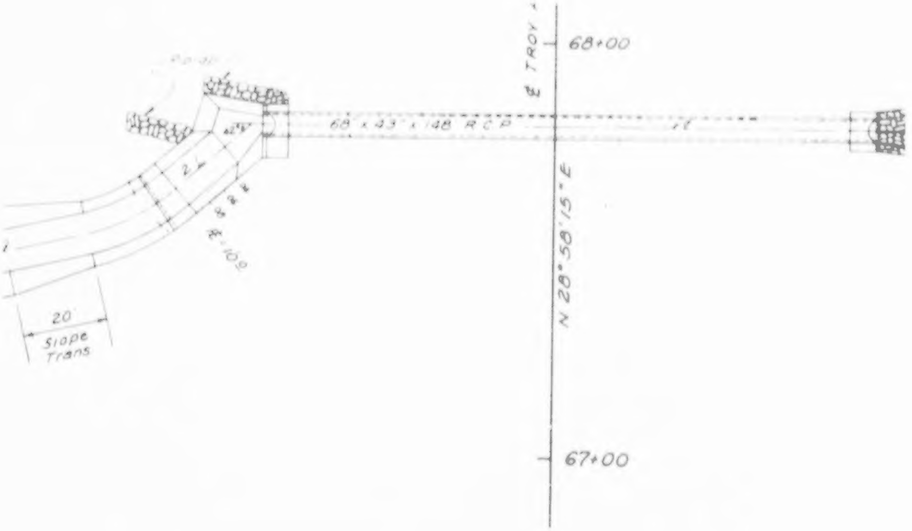
TEST

8. Identify the following major classes of maps.

(NOTE: Only partial maps are shown.)

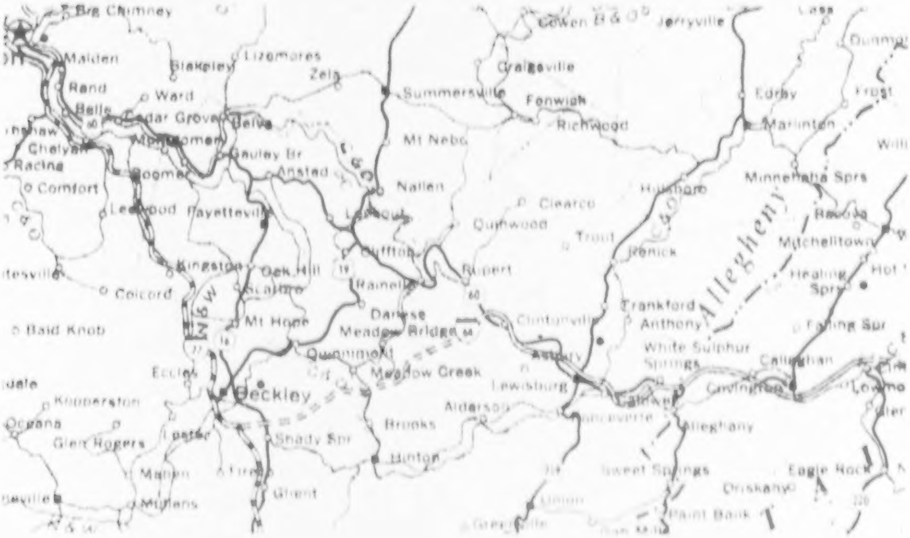

LOOKOUT MOUNTAIN
SCHO
Water Tank
Lookout
Mountain
Golden Res
Radio Tower
RESERVATION
PARK
BM 7374
Gulch
Deadman
4
3
Prospect
5998
6085
6090
5847

a. ______________________________

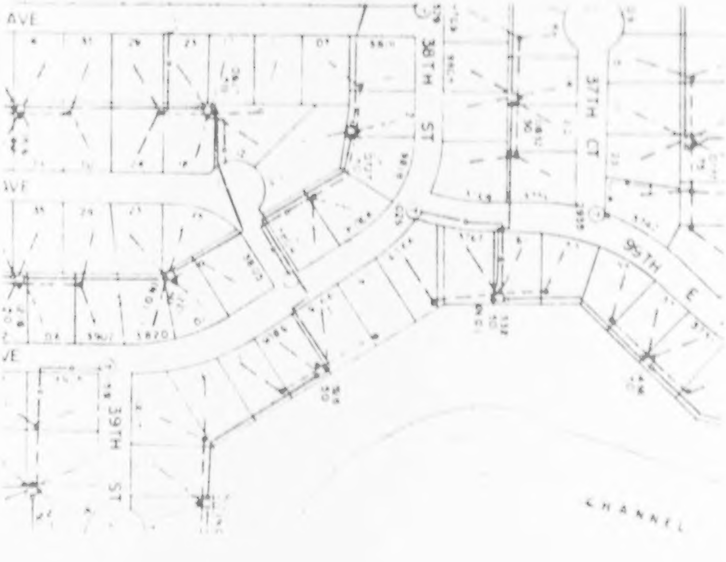

68+00
67+00
℄ TROY
N 28°58'15" E
68" x 43" x 148' RCP
20'
Slope Trans

b. ______________________________

TEST


Big Chimney
Malden
Rand
Belle
Ward
Cedar Grove
Blakeley
Lizemores
Zela
Summersville
Cowen
B & O
Jerryville
Cass
Craigsville
Fenwick
Richwood
Edray
Marlinton
Frost
Chelyan
Racine
Comfort
Montgomery
Belva
Gauley Br
Ansted
Boomer
Mt Nebo
Nallen
Hillsboro
Minnehaha Sprs
Leewood
Fayetteville
Lookout
Clearco
Quinwood
Trout
Renick
Allegheny
Mitchelltown
Kingston
Oak Hill
Scarbro
Rainelle
Rupert
Healing Sprs
Concord
Mt Hope
N & W
C & O
Danese
Meadow Bridge
Clintonville
Frankford
Anthony
White Sulphur Springs
Falling Spr
Bald Knob
Quinnimont
Meadow Creek
Asbury
Callaghan
Eccles
Beckley
Lewisburg
Caldwell
Covington
Kopperston
Oceana
Glen Rogers
Lester
Shady Spr
Brooks
Alderson
Ronceverte
Alleghany
Hinton
Ghent
Mullens
Sweet Springs
Eagle Rock
Oriskany
Union
Paint Bank
Greenville

c. ____


AVE
AVE
38TH ST
37TH CT
95TH E
39TH ST
CHANNEL

d. ____

TEST

9. Match major classes of maps on the right with the correct characteristics.

(NOTE: Classes on the right may be used more than once.)

______a. Are used primarily for showing political and civil boundaries, property lines, taxation, and transfer of property; are considered legal documents

______b. Use contour lines to show elevation; represent surface features of a region; large scale maps show all the natural features down to small streams and man-made features such as city streets, bridges, pipelines, etc.

______c. Show shorelines, water depths, information about harbors, anchorage details, and shipping approaches

______d. Show large area of land; are drawn to a small scale; only show major features such as rivers, lakes, and dots for cities

______e. Examples are maps for railroad, highway, canal, and hydroelectric construction, building site maps, landscape maps, dam and reservoir maps

______f. U.S.G.S. maps in this class are always bounded by meridians of longitude and latitude

______g. Are drawn for reconnaissance, construction, or maintenance purposes; can show more detail than topographic maps since they are larger in scale

______h. Show air traffic routes, radio and electronic aids, obstructions, and elevations of high points

______i. Examples include plats of city additions, mineral rights, and farm surveys

1. Geographic maps
2. Topographic maps
3. Cadastral maps
4. Engineering maps
5. Aeronautical charts
6. Hydrographic charts

TEST

10. Match typical drawings used in civil drawing on the right with the correct uses.

_____a. Provide the viewer a three-dimensional view of the map area

_____b. Are views of the inside of the project cut open at right angles to the survey centerline

_____c. Are drawings composed of a plan view and profile view

_____d. Identify the project with a name and number, show location map of the project, and give an index to all sheets in the plan set

_____e. Are enlarged drawings of an intersection of several streets that come together; show all pertinent information such as dimensions, right-of-ways, center lines, and curve data

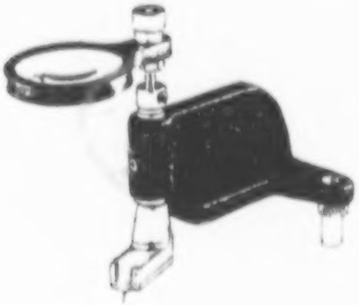
_____f. Are details that may show connections and flow directions through the use of symbols, lines, and dimensions

_____g. Provide a close up look at how a particular structural component is made; shows materials, dimensions, and section where needed

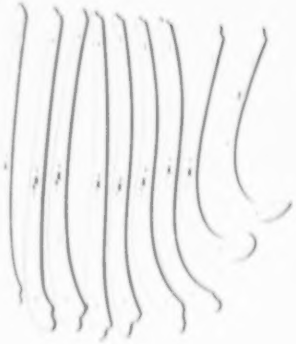
1. Title sheets (key maps)
2. Plan and profile
3. Typical cross sections
4. Structural details
5. Pictorial drawings
6. Schematic diagrams
7. Intersection details

TEST

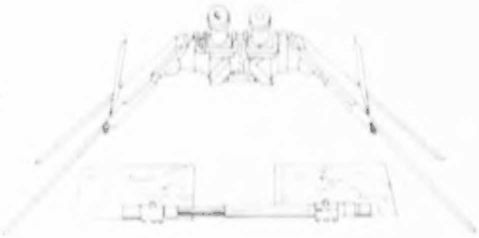
11. Identify the following drafting equipment used by civil drafters.



a. ________________________________

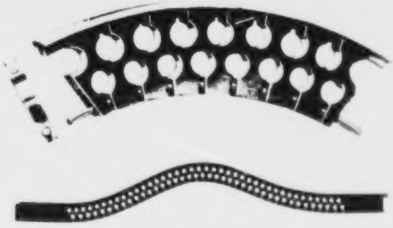


b. ________________________________

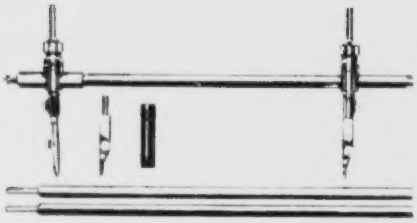


c. ________________________________

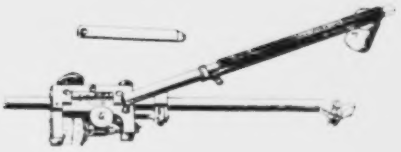
TEST



d. ______________________________

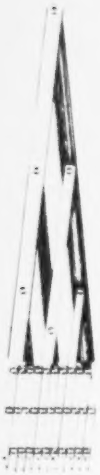


e. ______________________________

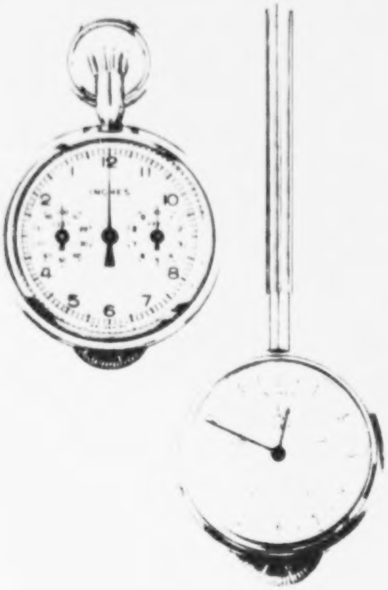


f. ______________________________

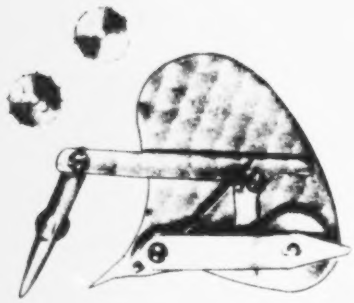
TEST



g. ________________________________



h. ________________________________



i. ________________________________

j. ________________________________

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

12. Take basic math pretest. (Assignment Sheet #1)

13. Interview a civil drafter. (Assignment Sheet #2)

14. Research possible employment opportunities in civil drafting in your local area. (Assignment Sheet #3)

INTRODUCTION TO CIVIL DRAFTING
UNIT I

ANSWERS TO TEST

1.

a.	10	l.	6
b.	16	m.	18
c.	9	n.	3
d.	1	o.	12
e.	15	p.	2
f.	4	q.	7
g.	11	r.	8
h.	19	s.	14
i.	5		
j.	17		
k.	13		

2. a,d,e,f,h,i

3. Any four of the following:
   a. Prepare maps and plans
   b. Work with survey data
   c. Gather, organize, and record data
   d. Perform engineering calculations
   e. Assist in the drafting and design of subdivisions, surface drainage systems, major structures, water treatment facilities, water distribution facilities, storm sewer systems, transportation systems, and/or utility facilities
   f. Communicate effectively

4. a. Private civil engineering and surveying firms
   b. Local government agencies
   c. Federal government agencies

5. a,d,f,g

6. Any seven of the following:
   a. Land planning and subdivision
   b. Transportation
   c. Flood control
   d. Irrigation and drainage
   e. Sewage and water treatment
   f. Municipal improvements
   g. Environmental studies
   h. Land and construction surveys
   i. Construction inspection
   j. Refuse disposal
   k. Map making

ANSWERS TO TEST

l. Power plants
m. Hydrologic studies
n. Foundation work and soil analysis
o. Agribusiness
p. Structural

7. a,b,c,e,i,j,l

8. a. Topographic
   b. Engineering
   c. Geographic
   d. Cadastral

9. a. 3
   b. 2
   c. 6
   d. 1
   e. 4
   f. 2
   g. 4
   h. 5
   i. 3

10. a. 5
    b. 3
    c. 2
    d. 1
    e. 7
    f. 6
    g. 4

11. a. Scribing tool
    b. Ship curves
    c. Stereoviewer
    d. Flexible curve rule
    e. Beam compass
    f. Planimeters
    g. Spacing divider
    h. Map measures
    i. Kern dotting pen and wheel
    j. Pantograph

12.-14. Evaluated to the satisfaction of the instructor

MAP SCALES AND MEASUREMENT
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to read and match different map scales with different classifications of maps, identify standard scale ratios used on topographic quadrangle maps, measure with a civil engineer's scale, and read a vernier scale. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to map scales and measurement with the correct definitions.
2. Complete a chart of standard measures and their equivalents.
3. Select true statements concerning characteristics of map scales.
4. List the three ways map scales are expressed.
5. Match the ranges of map scales with the appropriate map scale classifications.
6. List factors affecting the selection of a map scale.
7. Match types of maps with their common scales.
8. Select characteristics of a quadrangle scale.
9. Match quadrangle scales commonly used on U.S.G.S. topographic maps with their one inch equivalencies.
10. Select true statements concerning characteristics of graphic scales.

OBJECTIVE SHEET

11. Select true statements concerning published map accuracy standards.

12. Match types of scales used in civil drafting with the correct descriptions.

13. Convert a representative fraction to a graphic scale. (Assignment Sheet #1)

14. Read a vernier scale. (Assignment Sheet #2)

15. Measure with a civil engineer's scale. (Assignment Sheet #3)

MAP SCALES AND MEASUREMENT
UNIT II

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Develop a display of different scale topographic maps.
2. Have a speaker from a civil engineering office come in to discuss the importance of accuracy.
3. Review the scale units in MAVCC's *Basic Drafting, Book I*.
4. Use the tests from MAVCC's *Basic Drafting, Book I* scale units as a pretest.
5. Obtain additional pamphlets, brochures, and other material dealing with map scales and measurement from the U.S.G.S. at the following address:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092
Telephone: 703/860-6045

6. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

  1. TM 1 — Comparison of Topographic Map Scales
  2. TM 2 — Quadrangle Map Scales, Sizes, and Areas
  3. TM 3 — Graphic Scales
  4. TM 4 — Application of Metric Scales

D. Assignment sheets

  1. Assignment Sheet #1 — Convert a Representative Fraction to a Graphic Scale
  2. Assignment Sheet #2 — Read a Vernier Scale
  3. Assignment Sheet #3 — Measure with a Civil Engineer's Scale

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN WRITING THIS UNIT

A. Hoelscher, Randolph, Clifford Springer, and Jerry Dobrovolny. *Graphics for Engineers.* New York: John Wiley and Sons, Inc., 1968.

B. *Glossaries of BLM Surveying and Mapping Terms,* 2nd ed. Bureau of Land Management/U.S. Department of the Interior, 1980.

C. *Definitions of Surveying and Associated Terms.* American Congress on Surveying and Mapping and the American Society of Civil Engineers, 1978.

D. Nelson, John A. *Drafting for Trades and Industry: Civil.* Albany, NY: Delmar Publishers, 1979.

E. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

F. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

G. Bies, John and Robert Long. *Mapping and Topographic Drafting.* Cincinnati, OH: South-Western Publishing Co., 1983.

REFERENCES USED IN DEVELOPING THIS UNIT

H. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

I. *Map Accuracy.* Reston VA: U.S. Dept. of the Interior, Geologic Survey, National Cartographic Information Center.

J. Brinker, R.C. and P.R. Wolf. *Elementary Surveying.* 7th ed. New York: Harper & Row, 1984.

K. Giachino, J.W. and H.J. Beukema. *Drafting & Graphics.* Chicago, IL: American Technical Society, 1972.

L. *Map Concepts*, transparency set #526.98A0-5R. Longhorn Visual Aids, P.O. Box 1889. Big Springs, TX

M. Wirshing, Roy and James Wirshing. *Civil Engineering Drafting.* New York: McGraw-Hill Book Co., 1983.

SUGGESTED SUPPLEMENTAL MATERIALS

A. Davis, Ronald, et. al. *Basic Drafting, Book I.* Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1981.

B. Brown, R.L. "Proposed Manual on Selection of Map Uses, Scales, and Accuracies for Engineering and Associated Purposes: Map Availability." *ASCE Journal of the Surveying and Mapping Division*, 1980.

C. Feldscher, C.B. "A New Manual on Map Uses, Scales, and Accuracies." *ASCE Journal of the Surveying and Mapping Division*, 1980.

D. Thompson, M.M., and G.H. Rosenfeld. "On Map Accuracy Specifications." *Surveying and Mapping*, 1971.

MAP SCALES AND MEASUREMENT
UNIT II

INFORMATION SHEET

I. **Terms and definitions**

A. Accuracy — The degree of conformity of a measured or a calculated value to some recognized standard or specified value

B. Deviation — Variation from a specified dimension or design requirement, usually defining upper and lower limits

C. Full-divided scale — A scale with the basic units subdivided throughout the length of the scale

D. Graduations — The subdivisions in a scale unit, all of which are equal in size or length

E. Hectare — 2.471 acres

F. Meter (m) — The metric system standard for linear measurement

G. Metric system — A decimal system of weights and measures based on the meter and the kilogram

H. Neutral scale — A scale expressed as a fraction or a ratio

I. Nominal — Describes a value assigned for the purpose of convenient designation; existing in name only

J. NTS — Abbreviation meaning "not-to-scale"

K. Open-divided scale — A scale with only the end unit subdivided into fractional parts

L. Precision — The degree of mutual agreement between individual measurements, namely repeatability and reproducibility

M. Representative fraction (RF) — A simple ratio or fraction

Example: 1:24,000 or 1/24,000

N. Scale — An instrument used as a standard of reference when drawing an object to a proportional size

O. Scale ratio — A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn proportionally

P. Significant digit — Any numeral that is necessary to define a value or quantity

INFORMATION SHEET

Q. Tolerance — The total range of variation (usually bilateral) permitted for size, position, or other required quantity

R. U.S. customary units — Units based upon the yard and the pound commonly used in the United States

II. Standard measures and equivalents

1 mile = 1760 yards = 5280 feet = 1.6093 Km = 8 furlongs = 80 chains
1 yard = 3 feet = 36 inches = 0.9144 meter
1 foot = 12 inches = 0.3048 meter
1 inch = 2.54 centimeters
1 rod (also called *pole* or *perch*) = 5.5 yards = 16.5 feet = 0.5029 decameter

1 furlong = 10 chains = 220 yards
1 chain = 4 rods = 22 yards = 66 feet = 100 links = 2.0116 decameters
1 link = 7.92 inches
1 square mile = 640 acres = 6400 sq. chains
1 acre = 10 sq. chains = 4840 sq. yards = 43,560 sq. feet
An acre is equal to a square, one side of which is 208.7 feet

1 millimeter (mm) = 0.0393 inch
10 millimeters (mm) = 1 centimeter (cm) = .3937 inch
10 centimeters = 1 decimeter (dm) = 3.9370 inch
10 decimeters = 1 meter (m) = 39.3707 inches = 3.2808 feet = 1.0936 yards
10 meters = 1 decameter (Dm) = 32.8089 feet
10 decameters = 1 hectometer (Hm) = 19.9278 rods
10 hectometers = 1 kilometer (Km) = 1093.61 yards = 0.6213 miles
10 kilometers = 1 myriameter (Mm) = 6.2138 miles

III. Characteristics of map scales

A. Map scale is the relationship between a distance on a map and the corresponding distance on the ground.

B. A map scale expressed as 1:24,000 means that one unit of measurement on the map represents 24,000 of the same units on the earth's surface. If the unit is an inch, then 1 inch on the map equals 24,000 inches on the ground.

C. The first number (map distance) is always 1. The second number (ground distance) differs for each scale.

D. The **larger** the second number, the **smaller** the scale of the map.

Examples: 1:125,000 map is a smaller scale map than a map with a map scale of 1:100,000.

1:63,360 map is a smaller scale map than a map with a map scale of 1:62,500.

INFORMATION SHEET

IV. Ways map scales are expressed

A. By ratio or representative fraction

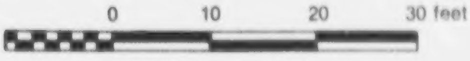
Example: 1:24,000 or 1/24,000

B. By equivalence

Example: 1 inch = 200 feet

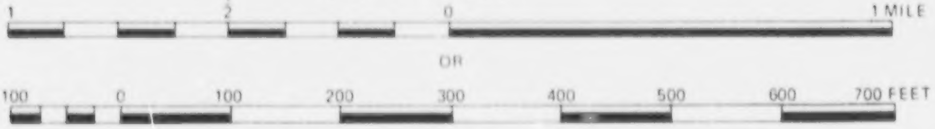
C. Graphically

Examples:



SCALE: 1"=10 FT

SCALE 1:24,000



V. Ranges of map scales

A. Large scale maps — 1 in = 100 ft (1:1200) or larger

B. Medium scale maps — 1 in = 100 to 1000 ft (1:1200 to 1:12,000)

C. Small scale maps — 1 in = 1000 ft (1:12,000 or smaller)

VI. Factors affecting the selection of a map scale

A. Size and character of the area to be shown

B. The form that the map is to be presented in

C. Purpose of the map

D. Cost of preparation and length of service (sometimes a consideration)

E. Required precision

VII. Common types of maps and corresponding map scales

A. Geographic maps — Scales vary from a few miles to the inch to several hundred miles to the inch

B. Topographic maps (Transparency 1)

1. Maps drawn at larger scales such as 1:24,000

a. Provide detailed information about the natural and man-made features of an area

INFORMATION SHEET

b. Are commonly used for highly developed areas in order to show more detail

2. Maps drawn at smaller scales such as 1:125,000

a. Can only show major features of an area

b. Can be used for more sparsely settled regions because there are not as many details to be shown

c. Allow large areas to be shown on a single map sheet.

C. Cadastral maps — Drawn at a scale usually greater than 6 inches to one mile which is necessary to obtain the required accuracy.

D. Engineering maps — Scales normally range from 1" = 20 ft. to 1" = 400 ft.

VIII. **Characteristics of a quadrangle scale** (Transparency 2)

A. Measures a standard four-sided area (quadrangle)

B. Bounded by lines of longitude and latitude

C. Set by the United States Geologic Survey

D. Most U.S. topographic maps cover 7.5 minutes of latitude and 7.5 minutes of longitude, and are commonly called "7.5-minute quadrangle" maps. These maps are drawn at a 1:24,000 scale.

IX. **Quadrangle scales commonly used on U.S.G.S. topographic maps**

Scale	1 inch equals
1:20,000	Approximately 1,667 feet
1:24,000	Exactly 2,000 feet
1:30,000	Exactly 2,500 feet
1:31,680	Exactly 1/2 mile
1:62,500	Approximately 1 mile
1:63,360	Exactly 1 mile
1:125,000	Approximately 2 miles
1:250,000	Approximately 4 miles
1:1,000,000	Approximately 16 miles

INFORMATION SHEET

X. **Characteristics of graphic scales** (Transparency 3)

   A. Are like small rulers that measure distances on a map

   (NOTE: A portion of a map can be measured by gauging the distance with dividers, then comparing it to the graphic scale.)

   B. Consist of a bar drawn at the same scale as the map

   C. Begin at zero

      1. Whole units are subdivided to the right of the zero.

      2. Smaller subdivisions of a whole unit are to the left of the zero.

   D. Are used anytime that a map may become subject to reduction, enlargement, or reproduction for use in reports

   E. Are more often used on topographic maps

   F. Are usually located in the margins or near the north arrow or legend of the map

XI. **Published map accuracy standards**

   A. Horizontal accuracy

      1. On maps with scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than $^{1}/_{30}$ inch.

      2. On maps with scales of 1:20,000 or smaller, the error factor is $^{1}/_{50}$ inch (0.05 centimeters).

      3. These limits of accuracy apply in all cases to positions of well-defined points that are easily visible or recoverable on the ground such as monuments, intersections of roads, or railroads.

      (NOTE: The well-defined point will be determined by what is plottable on the scale of the map within $^{1}/_{100}$ inch.)

   B. Vertical accuracy

      1. On contour maps (all publication scales), not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval.

      Example: If a map's contour interval is 10 ft, the map will correctly place 90 percent of all points tested within 5 feet (1.5 meters) of actual elevation.

INFORMATION SHEET

2. In checking elevations, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissable horizontal error for a map of that scale.

C. Published maps meeting these accuracy requirements must state in the legend "This map complies with National Map Accuracy Standards."

D. If a map is an enlargement of a published map, this fact should be stated in the legend, such as "This map is an enlargement of a 1:20,000-scale map drawing" or "This map is an enlargement of a 1:24,000-scale published map."

(NOTE: Individual engineering firms will have their standards of accuracy. A drafter needs to become familiar with these standards.)

XII. Scales used in civil drafting

(NOTE: Refer to MAVCC's *Basic Drafting, Book I* for an in-depth coverage of the architect's scale, civil engineer's scale, and metric scale. This unit serves to act as a review of these three scales.)

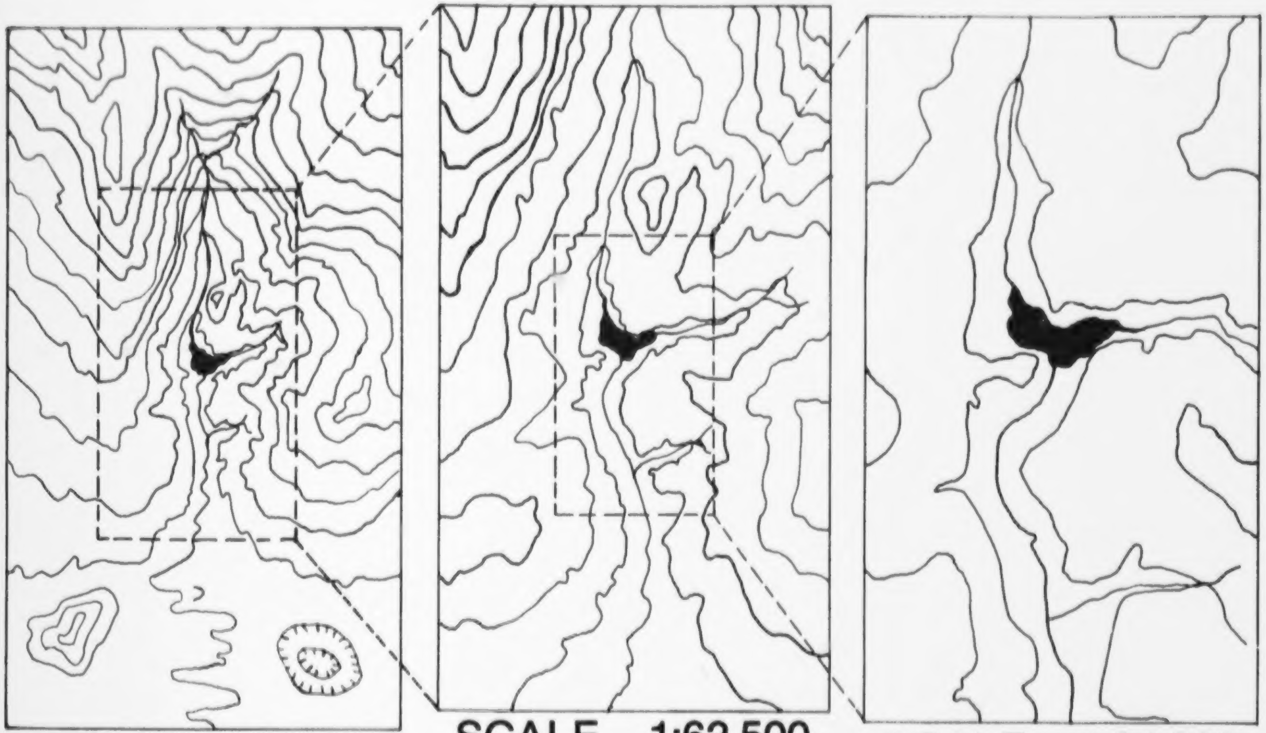
A. Architect's scale — Used primarily for drawings of buildings, piping systems, and other large structures which must be drawn to a reduced scale to fit on a standard sheet size. Only occasionally used for civil work. Has one full-size scale and ten reduced-size scales.

B. Civil engineer's scale — Used for civil engineering work. Graduated in units of one inch divided into 10, 20, 30, 40, 50, and 60 parts.

(NOTE: This is the preferred scale for civil work.)

C. Metric scale — Used primarily when the International System of Units (SI) metric method of measurement is in use. Graduated in millimeters, and uses scale ratios of 1:1, 1:2, 1:5, and 1:25. (Transparency 4)

Comparison of Topographic Map Scales



SCALE 1:125,000
Contour Interval 40 feet
2 Miles

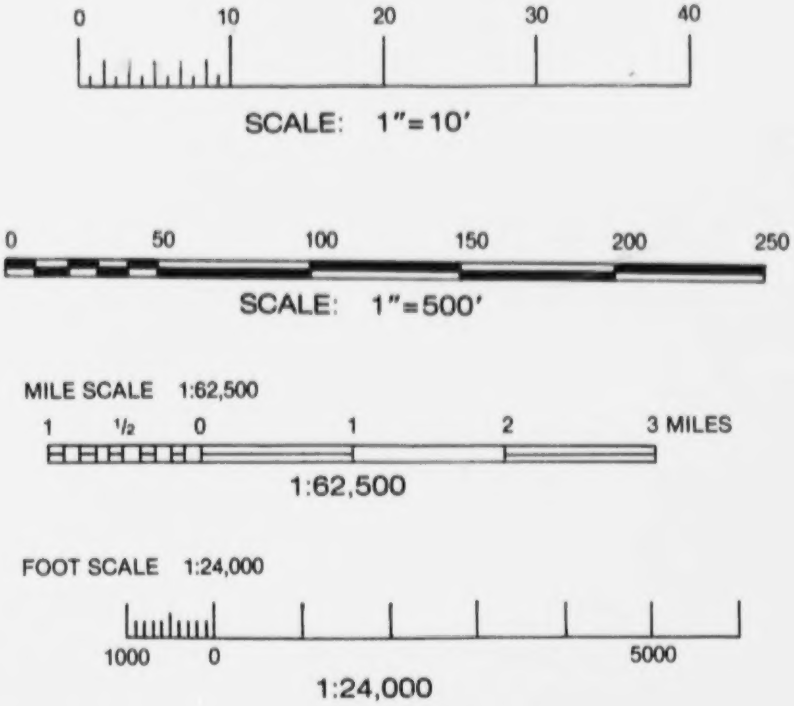
SCALE 1:62,500
Contour Interval 40 feet
1 Mile

SCALE 1:24,000
Contour Interval 40 feet
4/10 Mile

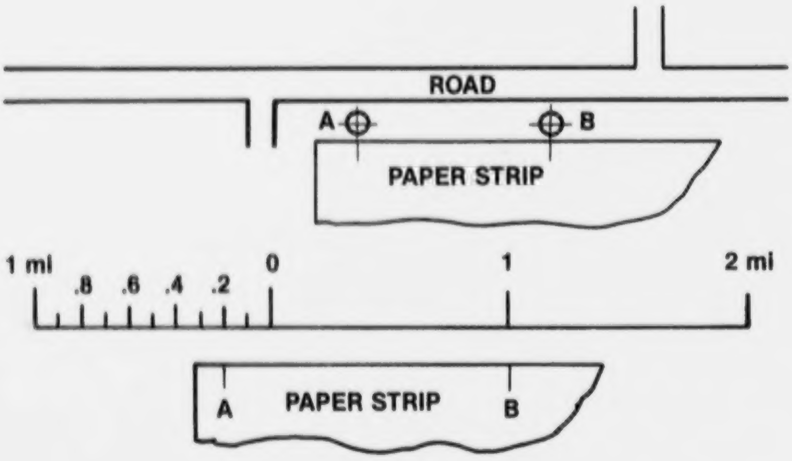
Quadrangle Map Scales, Sizes, and Areas

Series	Scale	1 inch represents approximately	1 centimeter represents	Size (latitude × longitude	Area (square miles)
Puerto Rico 7.5 minute	1:20,000	1,667 feet	200 meters	7.5 × 7.5 min.	71
7.5-minute	1:24,000	2,000 feet (exact)	240 meters	7.5 × 7.5 min.	49 to 70
7.5 × 15-minute	1:25,000	2,083 feet	250 meters	7.5 × 15 min.	98 to 140
USGS/DMA 15-minute	1:50,000	4,166 feet	500 meters	15 × 15 min.	197 to 282
15-minute	1:62,500	1 mile	625 meters	15 × 15 min.	197 to 282
Alaska 1:63,360	1:63,360	1 mile (exact)	633.6 meters	15 × 20 to 36 min.	207 to 281
County 1:50,000	1:50,000	4,166 feet	500 meters	County area	Varies
County 1:100,000	1:100,000	1.6 miles	1 kilometer	County area	Varies
30 × 60-minute	1:100,000	1.6 miles	1 kilometer	30 × 60 min.	1,568 to 2,240
U.S. 1:250,000	1:250,000	4 miles	2.5 kilometers	1° × 2° or 3°	4,580 to 8,669
Antarctica 1:250,000	1:250,000	4 miles	2.5 kilometers	1° × 3° to 15°	4,089 to 8,336
Antarctica 1:500,000	1:500,000	8 miles	5 kilometers	2° × 7.5°	28,174 to 30,462
State maps	1:500,000	8 miles	5 kilometers	State area	Varies
U.S. 1:1,000,000	1:1,000,000	16 miles	10 kilometers	4° × 6°	73,734 to 102,759
U.S. Sectional	1:2,000,000	32 miles	20 kilometers	State groups	Varies

Graphic Scales


0
10
20
30
40
SCALE: 1"=10'
0
50
100
150
200
250
SCALE: 1"=500'
MILE SCALE 1:62,500
1
½
0
1
2
3 MILES
1:62,500
FOOT SCALE 1:24,000
1000
0
5000
1:24,000

Sample Scales


ROAD
A
B
PAPER STRIP
1 mi
.8
.6
.4
.2
0
1
2 mi
A
PAPER STRIP
B

Measuring with a Graphic Scale

Application of Metric Scales

Metric mm:mm	Application
1:1 1:2 1:3 1:5 1:10	Machine drawings
1:20 1:25 1:33 1/3	Architectural construction details
1:75 1:100 1:200	Architectural plans and elevations Architectural plot plans
1:500 1:1250 1:2500 1:10,000 1:50,000	Maps (civil drawings)

MAP SCALES AND MEASUREMENT
UNIT II

ASSIGNMENT SHEET #1 — CONVERT A REPRESENTATIVE FRACTION TO A GRAPHIC SCALE

Map scales are often given in a ratio such as 1:24,000. In order to show a graphic scale, it is necessary to convert the ratio scale (RF scale) to a graphic scale for display on the map. An example of the conversion process follows.

(NOTE: Transparency 2 gives the common maps scales and their equivalents for future reference.)

Example: Given: RF scale 1:62,500

(NOTE: Remember 1 equals 1" on the map and 62,500 equals 62,500" on the earth's surface.)

Step 1 — Determine how many miles are represented by 62,500 inches.

(63,360 inches = 1 mile)
Divide 62,500 by 63,360 to determine the miles.

$$\frac{62{,}500}{63{,}360} = .98 \text{ miles}$$

(NOTE: This is not a practical scale to create a graphic scale.)

Step II — Determine how many inches are used to show any even numbers than the .98 miles previously determined. Let's use 2 miles.

$$\frac{.98}{1 \text{ in.}} = \frac{2 \text{ miles}}{\text{X (unknown no. of inches)}}$$

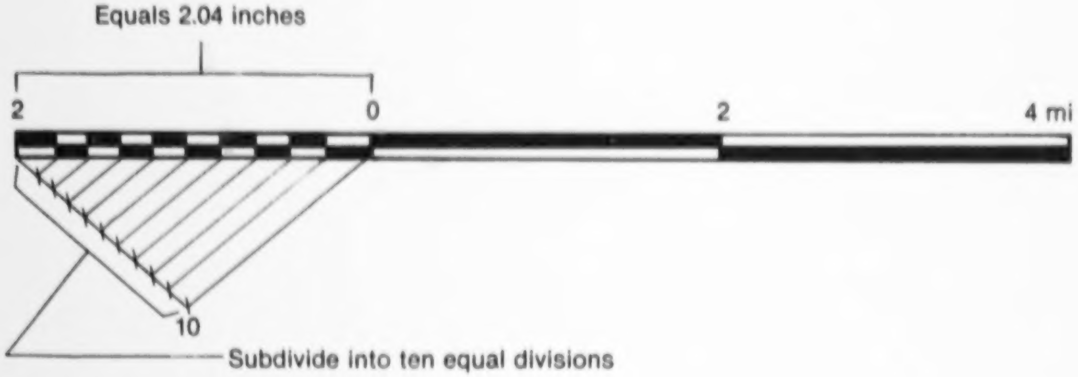
(NOTE: Use cross-multiplication to establish this algebraic formula.)

$$.98\,X = 2$$
$$X = 2.04''$$

In 2.04 inches we have 2 miles.

ASSIGNMENT SHEET #1

Step III — Lay off a graphic scale using the above information.


Equals 2.04 inches
2
0
2
4 mi
10
Subdivide into ten equal divisions

Assignment:

Given: 1:300,000 RF scale

Directions: 1) Convert the RF scale into a figure usable for a graphic scale.

2) Draw the graphic scale for this RF scale.

Step I:

= ____________ miles

Step II: Use 10 miles

$$\frac{\_\_\_\_}{1 \text{ in.}} = \frac{10 \text{ miles}}{X}$$

Step III: Draw the graphic scale here.

MAP SCALES AND MEASUREMENT
UNIT II

ASSIGNMENT SHEET #2 — READ A VERNIER SCALE

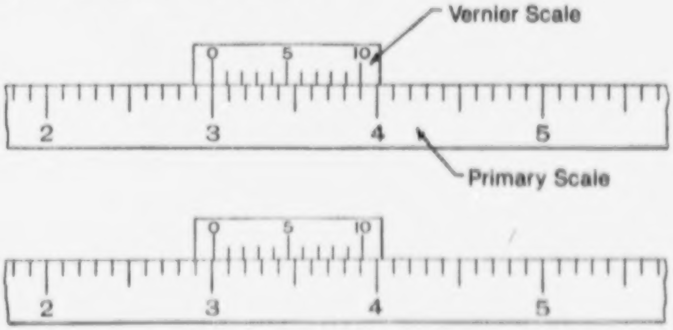
Vernier scales are found on some drafting machines. These are quite common in the civil drafting area. Follow the steps below to read a vernier scale.

Step I — Study the vernier scale (Figure 1)

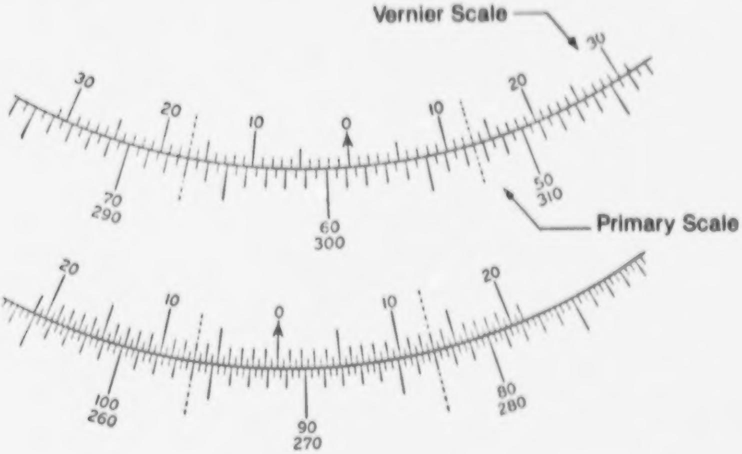
(NOTE: Several types of verniers are available. Determine what type yours is before attempting to read it.)

FIGURE 1

Direct or single verniers
(read in only one direction)


Vernier Scale
0
5
10
2
3
4
5
Primary Scale
0
5
10
2
3
4
5

Double verniers
(read either clockwise or counterclockwise)

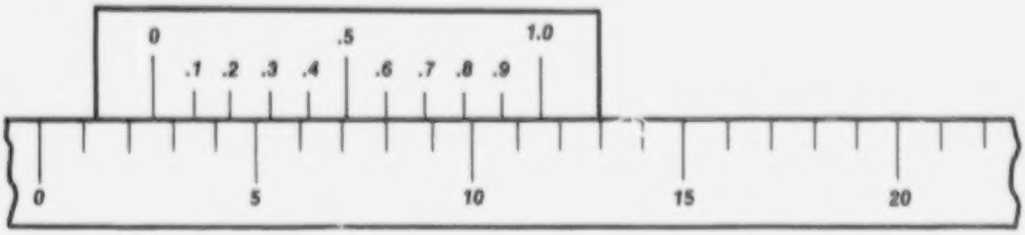

Vernier Scale
30
30
20
10
0
10
20
70
290
60
300
50
310
Primary Scale
20
10
0
10
20
100
260
90
270
80
280

ASSIGNMENT SHEET #2

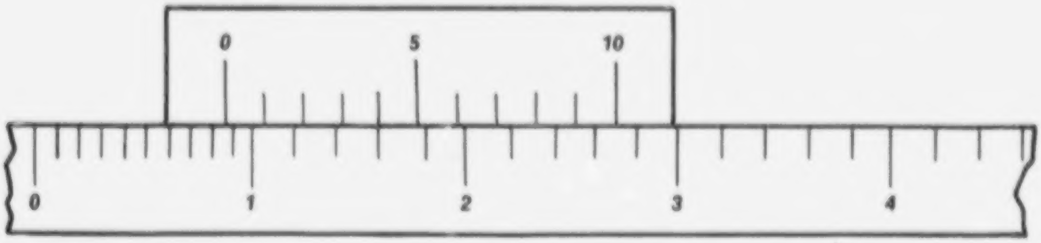
Step II: Read the arrow which indicates the nearest *full* division. Example 1 reads 2.

Step III: Moving from left to right on the vernier scale, find a line that lines up with another line; in this case it is .6. This reading is 2.6.

Example 1:

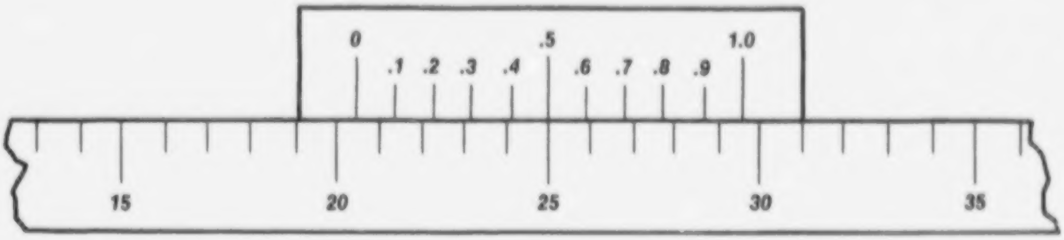

0
.5
1.0
.1 .2 .3 .4 .6 .7 .8 .9
0
5
10
15
20

Example 2: Moving from left to right, the arrow indicates 0. The .4 lines up with a line below. The reading is 0.4.



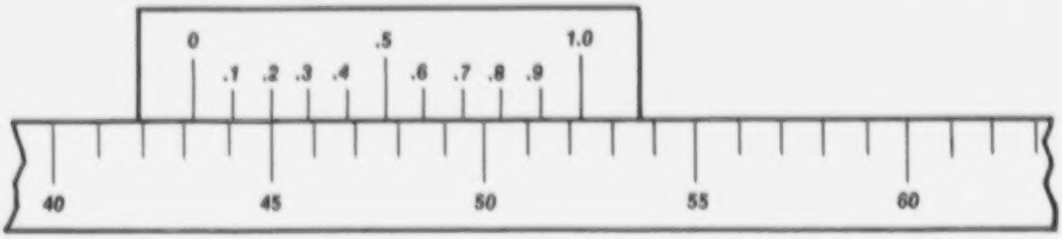
Assignment directions: Read the vernier scales below, and record your answers in the blanks below.

A. Answer ______________________________

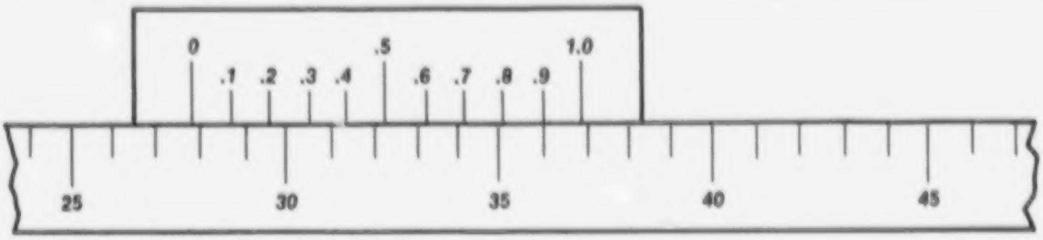

0
.5
1.0
.1 .2 .3 .4 .6 .7 .8 .9
15
20
25
30
35

ASSIGNMENT SHEET #2

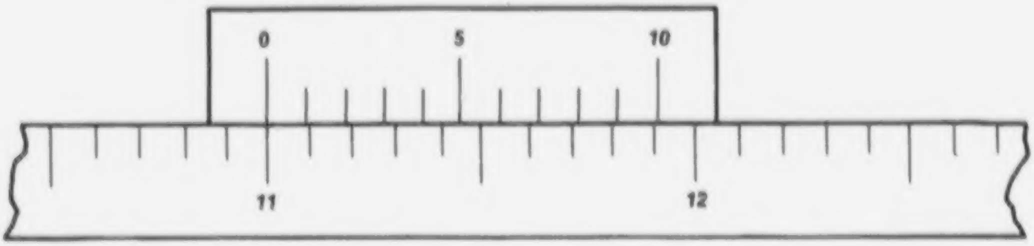
B. Answer ____


0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
40
45
50
55
60

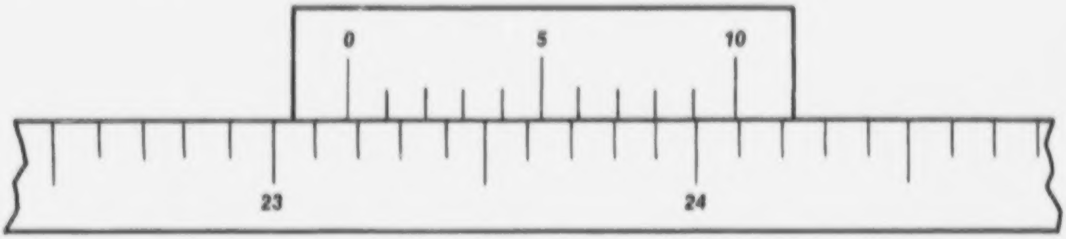
C. Answer ____


0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
25
30
35
40
45

D. Answer ____



E. Answer ____

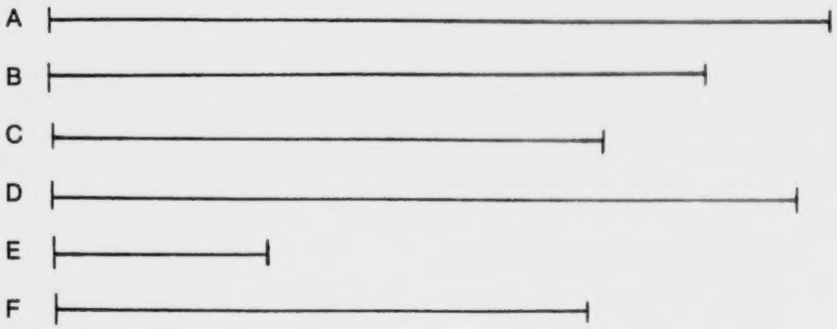


MAP SCALES AND MEASUREMENT
UNIT II

ASSIGNMENT SHEET #3 — MEASURE WITH A CIVIL ENGINEER'S SCALE

Directions: Use a civil engineer's scale to measure the lines A through F to the scale ratio heading each column in the table. Place the scale readings in the appropriate spaces in the table.

Example: On a 1″ = 10′ scale ratio, line A would be 44′ long; this figure should be lettered under the 1″ = 10′ column opposite letter A.



LINE	1″=10′	1″=20′	1″=300′	1″=40′	1″=500′	1″=60′	1″=10 MILES
A	44′						
B							
C							
D							
E							
F							

MAP SCALES AND MEASUREMENT
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

Step I — 4.73 miles

Step II — 2.11 inches

Step III — Evaluated to the satisfaction of the instructor

Assignment Sheet #2

A. 20.5

B. 43.2

C. 27.9

D. 11.0

E. 23.8

Assignment Sheet #3

LINE	1″=10′	1″=20′	1″=300′	1″=40′	1″=500′	1″=60′	1″=10 MILES
A	44′	88′	1320′	176′	2200′	264′	44 miles
B	37′	74′	1110′	148′	1850′	222′	37 miles
C	31′	62′	930′	124′	1550′	186′	31 miles
D	42′	84′	1260′	168′	2100′	252′	42 miles
E	12′	24′	360′	48′	600′	72′	12 miles
F	30′	60′	900′	120′	1500′	180′	30 miles

MAP SCALES AND MEASUREMENT
UNIT II

NAME ______________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. The degree of mutual agreement between individual measurements, namely repeatability and reproducibility

_____b. The degree of conformity of a measured or a calculated value to some recognized standard or specified value

_____c. A scale expressed as a fraction or a ratio

_____d. Any numeral that is necessary to define a value or quantity

_____e. Abbreviation meaning "not-to-scale"

_____f. A simple ratio or fraction

_____g. An instrument used as a standard of reference when drawing an object to a proportional size

_____h. A scale with only the end unit subdivided into fractional parts

_____i. A scale with the basic units subdivided throughout the length of the scale

_____j. A decimal system of weights and measures based on the meter and the kilogram

_____k. A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn proportionally

_____l. Units based upon the yard and the pound commonly used in the United States

_____m. The metric system standard for linear measurement

1. Accuracy
2. Deviation
3. Full-divided scale
4. Graduations
5. Hectare
6. Meter
7. Metric system
8. Neutral scale
9. Nominal
10. NTS
11. Open-divided scale
12. Precision
13. Representative fraction

TEST

______n. 2.471 acres

______o. Variation from a specified dimension or design requirement, usually defining upper and lower limits

______p. Describes a value assigned for the purpose of convenient designation; existing in name only

______q. The total range of variation permitted for size, position, or other required quantity

______r. The subdivisions in a scale unit, all of which are equal in size or length

14. Scale
15. Scale ratio
16. Significant digit
17. Tolerance
18. U.S. customary units

2. Complete the following chart of standard measures and their equivalents.

a. 1 mile = ______________ feet = ______________ chains

b. 1 inch = ______________ centimeters

c. 1 rod = ______________ yards

d. 1 furlong = ______________ chains

e. 1 chain = ______________ rods = ______________ links

f. 1 chain = ______________ yards = ______________ feet

g. 1 square mile = ______________ acres

h. 1 acre = ______________ sq. chains

i. 1 centimeter = ______________ millimeters

j. 1 meter = ______________ yards

3. Select the following true statements concerning map scales by placing an "X" next to the true statements.

______a. Map scale is the relationship between a distance on a map and the corresponding distance on the ground.

______b. A map scale expressed as 1:50,000 means that one unit of measurement on the map represents 50,000 of the same units on the earth's surface.

______c. The first number (map distance) is always 1. The second number (ground distance) differs for each scale.

______d. The larger the second number, the larger the scale of the map.

TEST

4. List the three ways maps scales are expressed.

a. ____________________

b. ____________________

c. ____________________

5. Match the ranges of map scales on the right with the appropriate map scale classifications.

_____a. Small scale maps

_____b. Medium scale maps

_____c. Large scale maps

1. 1 in = 1000 ft
2. 1 in = 100 ft
3. 1 in = 100 to 1000 ft

6. List three factors affecting the selection of a map scale.

a. ____________________

b. ____________________

c. ____________________

7. Match types of maps with their common scales.

_____a. Normally range from 1″ = 20 ft. to 1″ = 400 ft.

_____b. Usually greater than 6 inches to one mile which is necessary to obtain required accuracy

_____c. Vary from a few miles to an inch to several hundred miles to the inch

_____d. Depending upon degree of development in the region, can vary from smaller scales such as 1:125,000 to larger scales such as 1:24,000

1. Cadastral maps
2. Engineering maps
3. Geographic maps
4. Topographic maps

TEST

8. Select characteristics of a quadrangle scale by placing an "X" in the appropriate blanks.

______a. Set by the Department of Commerce

______b. Set by the Bureau of Land Management

______c. Set by the United States Geologic Survey

______d. Measures a standard four-sided area

______e. Measures irregular areas

______f. Bounded by lines of longitude and latitude

______g. Most U.S. topographic maps cover 15 minutes latitude and longitude and are drawn at 1:62,500 quadrangle scale

9. Match quadrangle scales commonly used on U.S.G.S. topographic maps listed on the right with their one inch equivalents.

1 inch equals

______a. Exactly 1/2 mile

______b. Exactly 2,000 feet

______c. Exactly 1 mile

______d. Exactly 2,500 feet

______e. Approximately 1 mile

______f. Approximately 16 miles

______g. Approximately 1,667 feet

______h. Approximately 4 miles

______i. Approximately 2 miles

Scales

1. 1:20,000
2. 1:24,000
3. 1:30,000
4. 1:31,680
5. 1:62,500
6. 1:63,360
7. 1:125,000
8. 1:250,000
9. 1:1,000,000

10. Select true statements concerning characteristics of graphic scales by placing an "X" in the appropriate blanks.

______a. Are like small rulers that measure distances on a map

______b. Consist of a bar drawn at the same scale as the map

______c. Begin at 50′

TEST

______d. Are used any time that a map may become subject to reduction, enlargement, or reproduction for use in reports

______e. Are most often used on engineering maps

______f. Are usually located in the margins or near the north arrow or legend of the map

11. Select true statements concerning published map accuracy standards by placing an "X" in the appropriate blanks.

______a. On maps with scales larger than 1:20,000, not more than 25 percent of the points tested shall be in error by more than 1/30 inch

______b. On maps with scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch

______c. On maps with scales of 1:20,000 or smaller, the error factor is 1/50 inch

______d. On maps with scales or 1:20,000 or smaller, the error factor is 1/30 inch

______e. These limits of accuracy apply in all cases to positions of well-defined points that are easily visible or recoverable on the ground such as monuments, intersections of roads, or railroads

______f. On contour maps (all publication scales), not more than 1 percent of the elevations tested shall be in error more than one-half the contours interval

______g. On contour maps (all publication scales), not more than 5 percent of the elevations tested shall be in error more than one-half the contours interval

______h. On contour maps (all publication scales), not more than 10 percent of the elevations tested shall be in error more than one-half the contours interval

12. Match types of scales used in civil drafting on the right with the correct descriptions.

______a. Used primarily for drawings of buildings, piping systems, and other large structures which must be drawn to a reduced scale to fit on a standard sheet size. Only occasionally used for civil work. Has one full-size scale and ten reduced-size scales.

______b. Used for civil engineering work. Graduated in units of one inch divided into 10, 20, 30, 40, 50, and 60 parts.

______c. Used primarily when the International System of Units (SI) metric method of measurement is in use. Graduated in millimeters and uses scale ratios of 1:1, 1:2, 1:5, and 1:25.

1. Civil engineer's scale
2. Metric scale
3. Architect's scale

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

13. Convert a representative fraction to a graphic scale. (Assignment Sheet #1)

14. Read a vernier scale. (Assignment Sheet #2)

15. Measure with a civil engineer's scale. (Assignment Sheet #3)

MAP SCALES AND MEASUREMENT
UNIT II

ANSWERS TO TEST

1.
   - a. 12
   - b. 1
   - c. 8
   - d. 16
   - e. 10
   - f. 13
   - g. 14
   - h. 11
   - i. 3
   - j. 7
   - k. 15
   - l. 18
   - m. 6
   - n. 5
   - o. 2
   - p. 9
   - q. 17
   - r. 4

2.
   - a. 5280 feet, 80 chains
   - b. 2.54 centimeters
   - c. 5.5 yards
   - d. 10 chains
   - e. 4 rods, 100 links
   - f. 22 yards, 66 feet
   - g. 640 acres
   - h. 10 sq. chains
   - i. 10 millimeters
   - j. 1.0936 yards (answer may be rounded)

3. a, b, c

4.
   - a. By ratio or representative fraction
   - b. By equivalence
   - c. Graphically

5.
   - a. 1
   - b. 3
   - c. 2

6. Any three of the following:
   - a. Size and character of the area to be shown
   - b. The form that the map is to be presented in
   - c. Purpose of the map
   - d. Cost of preparation and length of service (sometimes a consideration)
   - e. Required precision

7.
   - a. 2
   - b. 1
   - c. 3
   - d. 4

8. c,d,f

ANSWERS TO TEST

9.
a. 4
b. 2
c. 6
d. 3
e. 5
f. 9
g. 1
h. 8
i. 7

10. a,b,d,f

11. b,c,e,h

12.
a. 3
b. 1
c. 2

13.-15. Evaluated to the satisfaction of the instructor

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify symbols used in drafting, state abbreviations for words commonly used in civil drafting, and identify welding, structural material, and pipe symbols. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to standard symbols and abbreviations with the correct definitions.
2. List common types of symbols used in civil drafting.
3. State abbreviations for words commonly used in civil drafting.
4. Select true statements concerning factors that determine when an abbreviation should be used.
5. State two purposes of symbols on maps.
6. Identify U.S.G.S. topographic map symbols.
7. Identify other conventional topographic symbols.
8. Identify boundary, fence, and track fixture symbols.
9. Match civil symbols with the correct meanings.
10. Identify utility and service symbols.

OBJECTIVE SHEET

11. Match hydrographic and navigation symbols with the correct meanings.
12. Match geological structure symbols with the correct meanings.
13. Complete a chart of oil and gas symbols and their meanings.
14. Draw examples of north arrow symbols.
15. Select true statements concerning general rules for drawing map symbols.
16. List methods used in drawing symbols.
17. Match color codes with corresponding map symbols.
18. Identify common material symbols used in structural and architectural drawings.
19. Complete a chart of standard symbols for pipe fittings.
20. Identify common welding symbols.
21. Set up a map legend. (Assignment Sheet #1)
22. Locate and identify symbols and features on a U.S.G.S. map. (Assignment Sheet #2)

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make a transparency from the transparency master included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparency to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Refer to MAVCC's *Pipe Drafting*, Unit VI for more in-depth information on pipe drafting symbols.
2. Refer to MAVCC's *Mechanical Drafting*, Unit VI for more in-depth information on welding symbols.
3. Use a topographic map of your local area to locate specific symbols used on the map.
4. In future units of this book have the student find the abbreviations or symbols for the terms and definitions of each unit. This can be used as an assignment sheet.
5. Using vendor catalogs, look up the templates that can be used in civil drafting. List vendor, template name, number, and scale.
6. Daily, list a symbol or abbreviation on the chalkboard and have a mini quiz or contest on determining the correct feature or label these stand for.
7. Refer to ANSI standards Y14.5 to review with students the standard line conventions for drafting.
8. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency Master 1 — Parts of a Welding Symbol

D. Assignment sheets

  1. Assignment Sheet #1 — Set Up a Map Legend

  2. Assignment Sheet #2 — Locate and Identify Symbols and Features on a U.S.G.S. Map

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN WRITING THIS UNIT

A. Hoelscher, Randolph, Clifford Springer, and Jerry Dobrovolny. *Graphics for Engineers.* New York: John Wiley and Sons, Inc., 1968.

B. *Glossaries of BLM Surveying and Mapping Terms*, 2nd ed. Bureau of Land Management/U.S. Department of the Interior, 1980.

C. *Definitions of Surveying and Associated Terms.* American Congress on Surveying and Mapping and the American Society of Civil Engineers, 1978.

D. Nelson, John A. *Drafting for Trades and Industry: Civil.* Albany, NY: Delmar Publishers, 1979.

E. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

F. Bies, John and Robert Long. *Mapping and Topographic Drafting.* Cincinnati, OH: South-Western Publishing Co., 1983.

G. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

H. Brown, Walter. *Drafting for Industry.* South Holland, IL: Goodheart-Willcox, 1978.

I. Wirshing, Roy and James Wirshing. *Civil Engineering Drafting.* New York: McGraw-Hill Book Co., 1983.

SUGGESTED SUPPLEMENTAL MATERIALS

Sources for standardized symbols

A. Federal Board of Survey and Maps

B. National Oceanic and Atmospheric Administration (formerly U.S. Coast and Geodetic Survey)

C. U.S. Geological Survey

D. U.S. Forest Service

E. Defense Mapping Agency (DMA)

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

INFORMATION SHEET

I. **Terms and definitions**

A. Boundary — A line of demarcation between adjoining parcels of land

B. Cultural features — Man-made features such as railroads, bridges, roads, and public utilities

C. Geological — The structure and composition of the earth's crust

D. Hydrographic features — Features along the shore and the submerged parts of bodies of water

E. Legend — A description, explanation, table of symbols, and other information which is printed on a map or chart for better understanding and interpretation

(NOTE: The legend includes only those symbols that need an explanation. If a symbol is labeled on the map, it does not need to be included in the legend.)

F. Map scale — The relationship existing between a distance on a map and the corresponding distance on the earth

G. Natural land features — Features on a map such as lakes, streams, terrain, and vegetation

H. Navigation — Method of charting waters which affords a channel for useful commerce or travel

I. Planimetry — Showing the details of a map in plan view (generally culture and water features)

J. Symbol — A diagram, design, letter, or abbreviation which by convention or reference to a legend is understood to represent a specific characteristic or object

III. **Types of symbols commonly used in civil drafting**

A. Map symbols

B. Drawing symbols (ANSI standards for types of lines)

C. Labels in the form of abbreviations

D. Pipe symbols

E. Weldment symbols (types of welds)

F. Utility symbols

G. Material symbols

H. Oil and gas symbols

INFORMATION SHEET

III. Abbreviations of commonly used words in civil drafting

(NOTE: These are used on maps and drawings as labels.)

A

Abandoned	ABD
Abbreviations	ABBR
Above	ABV
Abutment	ABUT
Access	ACC
Acre	AC
Acre-foot	AC-FT
Addition	ADD.
Adjusting, adjacent	ADJ
Afternoon	PM
Aggregate	AGG
Alternate, altitude	ALT
Aluminum	AL
American Concrete Institute	ACI
American Institute of Steel Construction	AISC
American National Standards Institute	ANSI
Anchor	AHR
Anchor bolt	AB
Angle	Angle
Approach	APPR
Approved	APPD
Approximate	APPROX
Apron	APR
Area	A
Area drain	AD
Article	ART.
Asbestos	ASB
Asbestos cement, asphaltic concrete	AC
Asphalt	ASPH
Assembly	ASM
Assistant	ASST
Associate	ASSOC
Association	ASSN
Automatic	AUTO
Auxiliary	AUX
Avenue	AVE
Average	AVG
Avoirdupois	AVDP
Azimuth	AZ

B

Background	BKGD
Backsight	BS (°)
Back to back	B to B
Barbed wire	BW
Barrel	BBL
Baseline	BL or $\overset{B}{L}$
Basement	BSMT
Bearing	BRG
Bearing value	BV
Begin	BEG
Beginning of project	BOP
Bell and spigot	B & S
Below	BLW
Bench mark/Beam	BM
Between	BETW
Beveled	BEV
Bituminous	BIT
Bituminous coated corrugated metal pipe culvert	BCCMP
Bituminous coated and paved corrugated metal pipe culvert	BCPCMP
Bituminous coated pipe arch culvert	BCPA
Bituminous coated and paved pipe arch culvert	BCPPA
Black/block	BLK
Board	BD
Board feet	FBM
Bolt	BLT
Bottom	BOT
Boulders	B
Boulevard	BLVD
Boundary	BNDY/BDY
Bridge	BR
Brook	Brook
Brown	BRN
Building	BLDG
Built-up	B/U
Bulkhead	BLKHD
Bureau of Public Roads	BPR
Bushel	BU
Butterfly valve	BV

C

Capacity	CAP
Capital	CAP
Cast iron	CI
Cast iron pipe	CIP
Cast iron soil pipe	CISP
Catch basin	CB
Ceiling	CLG
Cement, Cemetery	CEM
Centerline	CL
Center	CTR
Centers	CTRS
Center to center	C to C
Centimeter(s)	CM
Chain	CH
Change	CHG
Channel	Channel
Checked	CKD
Church	CH
Circular	CIR
Clay	CL
Clear, clearance	CLR
Cleanout	CO
Coated	CTD
Coefficient	COEF
Column	COL
Computations	COMP
Concrete	CONC
Concrete cylinder pipe	CCP

INFORMATION SHEET

Concrete masonry units	CMU
Concrete pipe	CP
Connection	CX, CONN
Construction	CONST
Construction joint	CJ
Continuation	CONT
Continuous	CONT
Continued	CONTD
Contract	CONT
Contract limit line	CCL
Contractor	CONTR
Contraction	CONTR
Control	CONT
Control of access	CofA
Coordinate	COORD
Corner	COR
Corrugated iron	CORR I
Corrugated metal	CM
Corrugated metal pipe	CMP
Corrugated metal pipe arch culvert	CMPA
County	CO
County road	CO RD
Creek	CR
Cross road	X RD
Cross section	X SECT
Cubic	CU
Cubic foot	CF
Cubic feet per minute	CFM
Cubic feet per second	CFS
Cubic yard	CY
Culvert	CULV
Curb and gutter	C&G
Curve to spiral	CS
Cylinder	CYL

D

Degree	DEG
Degree of curvature	D
Delta	Delta
Demolish, demolition	DEM
Department	DEPT
Depressed	DEP
Designed	DSGN
Diagonal	DIAG
Diameter	D or DIAM
Dimension	DIM
Directional	DIR
Distance	DIST
Down	DN
Drawn	D or DR
Drawing	DWG
Drawings	DWGS
Drop inlet	DI

E

Each	EA
Each face	EF
Each way	EW
East	E
Elbow	ELL
Electric(al)	ELEC
Electronic distance meter	EDM
Elevation (above sea level)	EL
Elevation (view)	ELEV
Emergency	EMERG
Enclosure	ENCL
End of project	EOP
End to end	E to E
End vertical curve	EVC
Engineer	ENGR
Engineering	ENGG
Equal	EQ
Equally spaced	EQL SP
Equation	EQ
Equipment	EQPT
Equivalent	EQUIV
Estimate	EST
Excavation	EXC
Existing	EXST
Expansion	EXP
Expansion joint	EXP JT
Extension, Exterior, External	EXT
External distance	E
Extra	Extra

F

Face of concrete	FOC
Face to face	F to F
Federal	FED
Federal Aid	FA
Federal Aid Interstate	FAI
Federal Aid Primary, Federal Aid Project	FAP
Federal Aid Secondary	FAS
Feet	FT
Feet board measure	FBM
Feet per minute	FPM
Feet per second	FPS
Ferry	FY
Figure	FIG
Finish grade	FG
Fire hydrant	FH
Flange, flanged	FLG
Flexible	FLEX
Floor, floor line, flow	FL
Floor cleanout	FCO
Floor drain	FD
Flow line	FLL
Flush hole	FH
Foot	FT
Footing	FTG
Ford	FD
Forenoon	AM
Foresight	FS
Foundation	FDN
Frontage road	FNTG RD
Full size	FS
Future	FUT

G

Gage	GA
Gallon	GAL
Gallons per minute	GPM
Gallons per second	GPS
Galvanized iron	GI
Gate valve	GTV

INFORMATION SHEET

General	GENL
Granite	GRN
Gravel	GVL
Green	GRN
Grid north	GN
Ground	GRD/GND

H

Handrail	HR
Header	HDR
Height	HGT
Height of instrument	HI
Hexagonal	HEX
High water	HW
Highway	HWY
Horizontal	HORIZ
Horsepower	HP
Hose bib	HB
Hour	HR
House	HSE or H
Hub drain	HD

I

Inch	IN
Including	INCL
Incorporated	INC
Information	INF
Influent	INFL
Inside diameter	ID
Inside face	IF
Installation	INSTL
Interlock	ILK
Intermediate	INTER/INTM
Interstate highway	IH
Iron pipe, iron pin	IP
Invert	INVT
Invert elevation	IE

J

Joint	JT
Junction	JNCT/JCT/JT
Junction box	JB

L

Lake	Lake
Lateral	LATL
Latitude	LAT
Left	LT
Length	LGTH
Length of curve	L
Length of tangent	T
Light	LT
Lighting	LTG
Limestone	LMS
Linear	LIN
Linear foot	LIN FT
Longitude, Longitudinal	LONG
Low point	LPT
Low water	LW
Manhole	MH
Material	MTL

M

Maximum	MAX
Mean sea level	MSL
Median	MED
Membrane	MMB
Meridian	MER
Mile	MI
Miles per hour	MPH
Millimeter(s)	MM
Minimum, Minute	MIN
Miscellaneous	MISC

N

National	NATL
National Geodetic Survey	NGS
Negative	NEG
Nominal	NOM
North	N
Northeast	NE
Northwest	NW
Not applicable	NA
Not to scale	NTS
Number	NO
Numbers	NOS

O

Obscure	OBS
On center	OC
Opening	OPNG
Opposite	OPP
Orange	ORN
Original	ORIG
Ounce	OZ
Outside diameter	OD
Outside face	OF
Outside to outside	O to O
Overall	OA

P

Page	P
Pages	PP
Paragraph, Parallel	PAR
Parking	PK
Piling	PLG
Piping	PP
Plan and profile sheet	P&P SHEET
Pave(d)(ing)	PV
Pavement	PVMT,PAVT
Plane	PL
Plate, property line	PL
Point	PT
Point of beginning	POB
Point of compound curvature	PCC
Point of curvature	PC
Point of intersection	PI
Point of reverse curve	PRC
Point of tangency	PT
Point on curve	POC
Point on tangent	POT
Polyvinyl chloride	PVC
Portland cement concrete	PCC

INFORMATION SHEET

Pound	LB
Pounds per square inch gauge	PSIG
Power	PWR
Power pole	PP
Precast	PRCST
Pressure	PRES
Pressure reducing valve	PRV
Primary	PRI
Principal meridian	PRIN MER
Project	PROJ

Q

Quadrangle	QUAD
Quart	QT

R

Radius	R or RAD
Railroad	RR
Railway	RY
Rain drain, roof drain	RD
Range	R
Received	RECD
Reduction	REDUC
Reference	REF
Reference point	RP
Reflector	REFL
Regular	REG
Reinforced	REINF
Reinforced concrete	RC
Reinforced concrete pipe	RCP
Reinforcement, reinforcing	REINF
Remove	RMV,REM
Replace	REPL
Required	REQD
Reverse	RVS
Revision	REV
Right	RT
Right lane	RT LN
Right-of-way	R/W, ROW
River	R
Road	RD
Roadway	RDY
Round	RD
Route	RTE

S

Sanitary sewer	SAN S
Schedule	SCH, SCHED
Second	SEC
Secondary	SECD
Section	SECT
Section line	SL or S L
Separate	SEP
Service	SERV
Sheet	SH
Shore(d)(ing)	SHO
Signal	SIG
South	S
Southeast	SE
Southwest	SW
Special	SPL
Specification(s)	SPEC
Spillway	SPLWY
Spiral to curve	SC
Spiral to tangent	ST
Square	SQ
Square foot	SQ FT
Square inch	SQ IN
Square mile	SQ MILE
Square yard	SQ YD
Standard	STD
State	State
State Aid Project	SAP
State highway	SH
State work order	SWO
Station	STA
Steel	STL
Storm sewer	SS
Straight, Stream	STR
Street	ST
Structure, Structural	STR
Submerged	SUBMG
Substructure	SUBSTR
Superstructure	SUPERSTR
Support	SUP
Survey	SURV
Symmetrical	SYM
System	SYS

T

Tangent	TAN/T
Telegraph	TELG
Telephone	TELP
Telephone pole	TP
Temperature, temporary	TEMP
Temporary benchmark	TBM
Terminal	TERM
Terra cotta	TC
Thick	THK
Thickness	THKNS
Thousand	M
Tolerance	TOL
Tongue and groove	T&G
Top and bottom	T&B
Top face	TF
Top of	TO
Top of concrete	TC
Top of steel	TST
Top of wall	TW
Topography	TOPO
Township	TWP/T
Transom	TR
Transverse	TRANSV
True north	TN
Turning point	TP
Typical	TYP

INFORMATION SHEET

U

Undercut	UC
Underground	UG
Upstream	UPSTR
U.S. Geological Survey	USGS
U.S. Coast & Geodetic Survey	USC & GS

V

Variable	VAR
Vertical	VERT
Vertical curve	VC
Vertical grain	VG
Volume	VOL

W

Water surface, waterstop, welded steel	WS
Water tank, Weight	WT
West	W
White	WHT
With	W/
Without	W/O
Working point	WP

Y

Yard	YD
Year	YR
Yellow	YEL

IV. Factors that determine the usage of an abbreviation

A. Use an abbreviation when necessary to save time and space.

B. Use an abbreviation only when the meaning is unquestionably clear to the intended reader.

C. Be sure to use a standard abbreviation, not your own shortened version.

(NOTE: When in doubt, spell it out.)

V. Purposes of symbols on maps

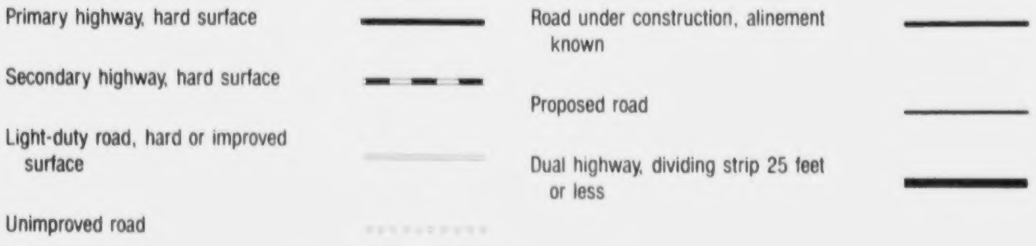
A. To represent the location and identity of land features that are generally too large to be shown in detail on the map

B. To help keep information on a map to a minimum and thereby avoid cluttering

(NOTE: The purpose of the map dictates the types of symbols used.)

VI. U.S.G.S. topographic map symbols

(NOTE: Variations will be found on older maps.)

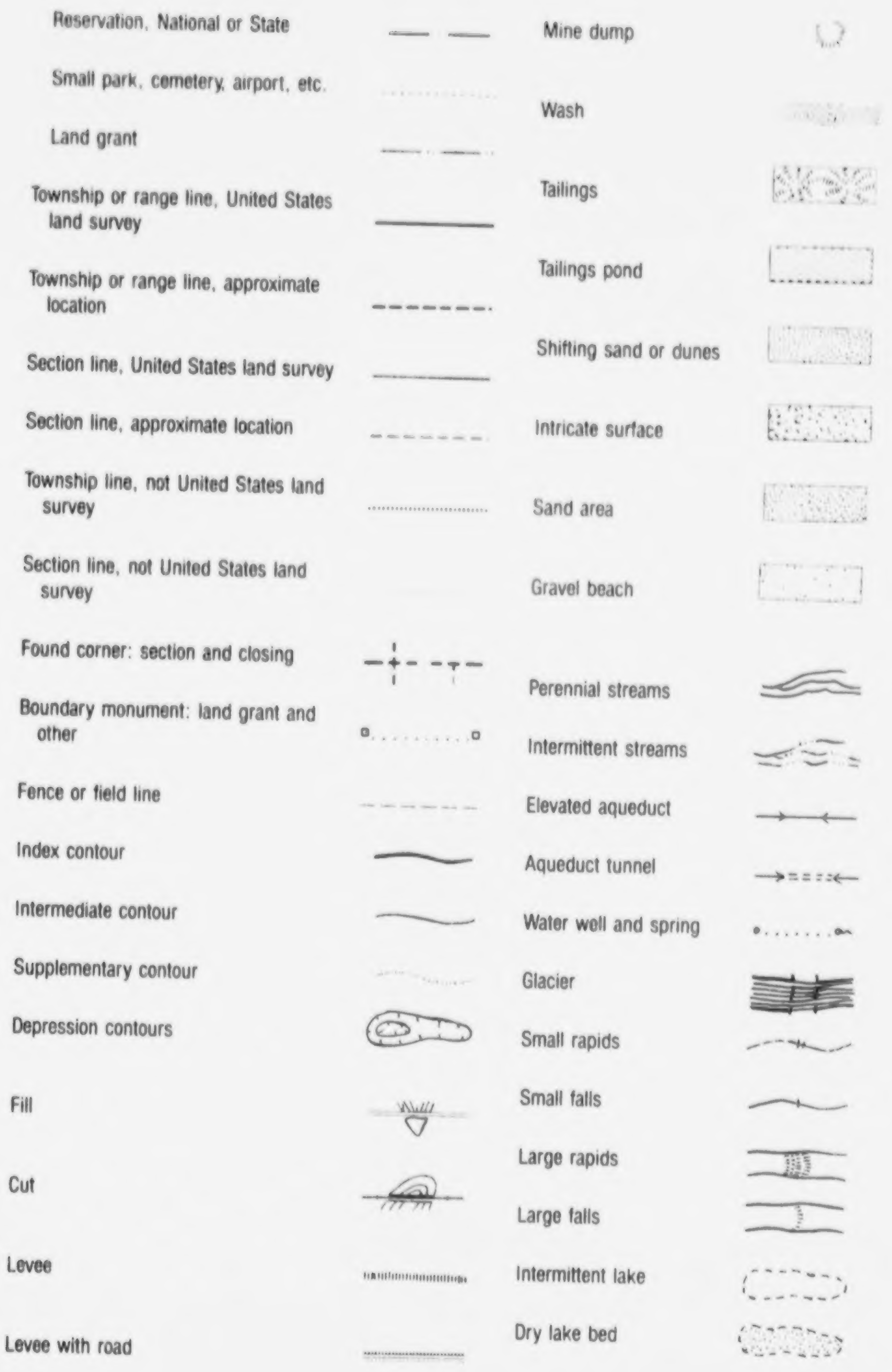

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Road under construction, alinement known
Proposed road
Dual highway, dividing strip 25 feet or less

INFORMATION SHEET

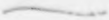
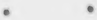
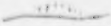
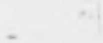
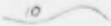
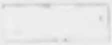
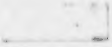
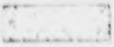
Dual highway, dividing strip exceeding 25 feet	
Trail	
Railroad: single track and multiple track	
Railroads in juxtaposition	
Narrow gage: single track and multiple track	
Railroad in street and carline	
Bridge: road and railroad	
Drawbridge: road and railroad	
Footbridge	
Tunnel: road and railroad	
Overpass and underpass	
Small masonry or concrete dam	
Dam with lock	
Dam with road	
Canal with lock	
Buildings (dwelling, place of employment, etc.)	
School, church, and cemetery	Cem
Buildings (barn, warehouse, etc.)	
Power transmission line with located metal tower	
Telephone line, pipeline, etc. (labeled as to type)	

Wells other than water (labeled as to type)	○ Oil ○ Gas
Tanks: oil, water, etc. (labeled only if water)	● ● ● ◍ Water
Located or landmark object; windmill	
Open pit, mine, or quarry; prospect	
Shaft and tunnel entrance	
Horizontal and vertical control station:	
Tablet, spirit level elevation	BM △ 5653
Other recoverable mark, spirit level elevation	△ 5455
Horizontal control station: tablet, vertical angle elevation	VABM △ 9519
Any recoverable mark, vertical angle or checked elevation	△ 3775
Vertical control station: tablet, spirit level elevation	BM × 957
Other recoverable mark, spirit level elevation	× 954
Spot elevation	× 7369 × 7369
Boundaries: National	
State	
County, parish, municipal	
Civil township, precinct, town, barrio	
Incorporated city, village, town, hamlet	

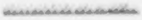
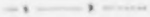
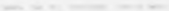
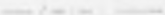
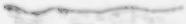
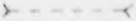
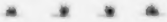
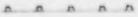
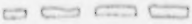
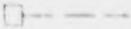
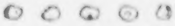
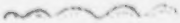
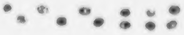
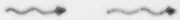
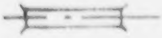
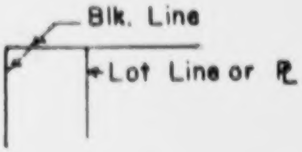
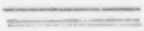
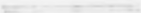
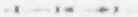
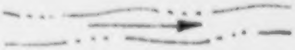
INFORMATION SHEET


Reservation, National or State
Small park, cemetery, airport, etc.
Land grant
Township or range line, United States land survey
Township or range line, approximate location
Section line, United States land survey
Section line, approximate location
Township line, not United States land survey
Section line, not United States land survey
Found corner: section and closing
Boundary monument: land grant and other
Fence or field line
Index contour
Intermediate contour
Supplementary contour
Depression contours
Fill
Cut
Levee
Levee with road
Mine dump
Wash
Tailings
Tailings pond
Shifting sand or dunes
Intricate surface
Sand area
Gravel beach
Perennial streams
Intermittent streams
Elevated aqueduct
Aqueduct tunnel
Water well and spring
Glacier
Small rapids
Small falls
Large rapids
Large falls
Intermittent lake
Dry lake bed

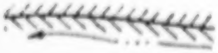
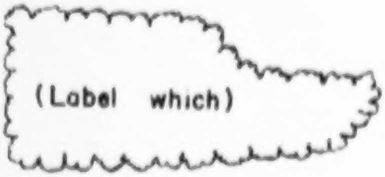
INFORMATION SHEET

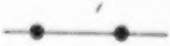
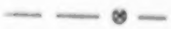
Foreshore flat		Rock, bare or awash; dangerous to navigation	
Rock or coral reef		Marsh (swamp)	
Sounding, depth curve		Submerged marsh	
Piling or dolphin		Wooded marsh	
Exposed wreck		Mangrove	
Sunken wreck			

VII. Other conventional topographic symbols

City line		Store	
Fence line		House	
Right-of-way line		Barn	
Limited access line		School	
Shore line		Existing side drain pipe	
Marsh		Proposed fence (limited access)	
Hedge		Inlet (drainage map)	
Trees		Manhole	
Edge of wooded area		High water elevation	H W EL
Shrubbery		Direction of flow	
Bridges over 20£ span		Block and lot lines	
Curb and gutter (proposed) dash existing curb and gutter			
Curb (proposed) dash existing curb			
Gate			
Church		Creeks and rivers	

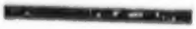
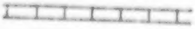
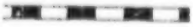
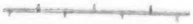
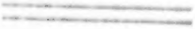
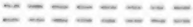
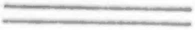
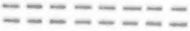
INFORMATION SHEET

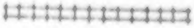
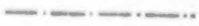
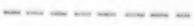
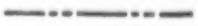
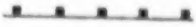
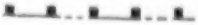
Terraces (ticks pointing down grade)	
Timber, orchard, brush or nursery	

R/W line and marker in place	
R/W line and marker new	
Point of intersection (PI)	△
Principal points along survey ℄	•
Horizontal control station	

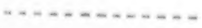
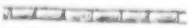
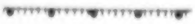
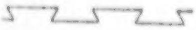
VIII. **Boundary, fence, and track fixture symbols**

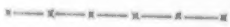
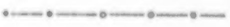
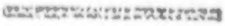
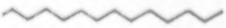
A. Details of railways, boundary and survey lines

Steam	
Electric	
Street Rwy	
Narrow gauge	
Present track to remain	
Present track to be removed	
Proposed track (Red)	
Proposed future track (Red)	

Foreign Track (Show rd. initials) (color other than red or black)	
Foreign R. of W. Line	
Center line	
Company R of W (property line)	
Fence on street	
Fence on Rwy property line	

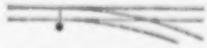
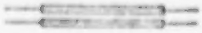
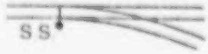
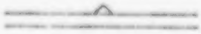
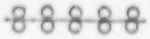
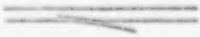
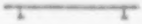
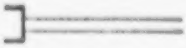
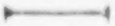
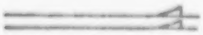
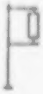
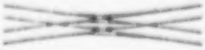
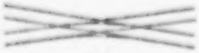
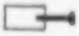
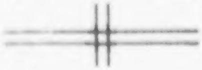
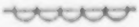
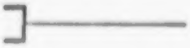
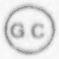
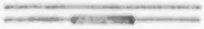
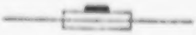
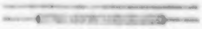
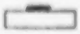
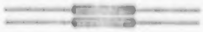
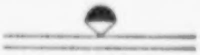
B. Fences

Board fence or fence in general	
Stone fence	
Picket fence	
Rail fence	

Barbed wire fence	
Smooth wire fence	
Hedge fence	
Worm fence	

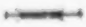
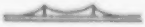
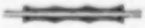
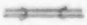
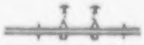
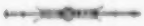
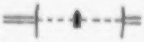
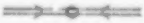
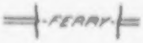
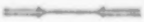
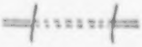
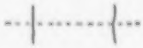
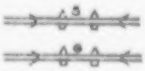
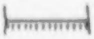
INFORMATION SHEET

C. Details of track fixtures and accessories

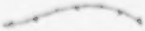
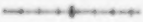
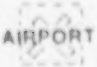
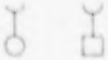
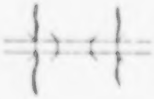
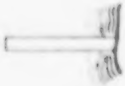
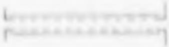
Turnout and switch stand		Double car retarder	
Spring switch		Electric light	
Detail (block)		Flood lighting tower	
Derail (Switch pt.)		Rail rest	
Bumping post		Gantry crane	
Friction car stop		Mail crane	
Double slip sw.			
Single slip sw.		Boom crane	
Crossing		Track pan	
Bumping post		Gas container	
Single car retarder		Track scale	
Double car retarder		Stock scale	
Single car retarder		Rail lubricator	

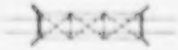
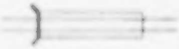
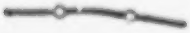
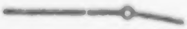
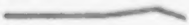
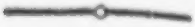
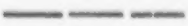
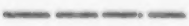
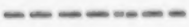
IX. Civil symbols

A. On plan sheets

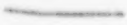
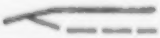
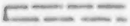
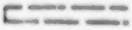
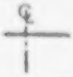
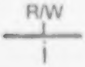
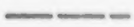
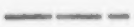
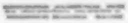
Bridge — general symbol, R.R.		Suspension bridge	
		Arch bridge	
Bridge -- general symbol, hwy		Pontoon bridge	
Drawbridge — R.R.		Ferry	
Drawbridge — hwy		Ferry	
Footbridge		Ford road	
		Ford trail	
Truss bridge (W, wood; S, steel; G, girder)		Dam	

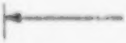
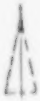
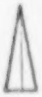
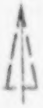
INFORMATION SHEET

Telephone or telegraph line	T T T T T T
Telephone line	
Railroad station of any kind	
Airport	
Mosque	
Lift bridge	
Pier	
Tunnel	

Truss	
Girder	
Const. center line	
Present ctr. line	
Profile grade	
Ground line	
Subcut	
Ditch grade rt.	
Ditch grade lt.	

B. On cross section sheets

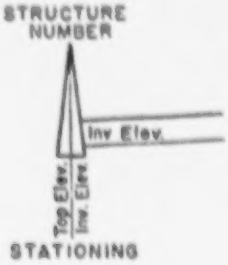
Ground line	
Const. cross section	
Subcut	
Culvert inp.	
New culvert	
Center line	
Right of way	
Entrance	
Ditch block	
Water	

Dimension line	
Existing manhole	
Proposed manhole	
Future manhole	

INFORMATION SHEET

Existing pipes or culverts	⬯
Proposed pipes or culverts	⬯

Structure number stationing

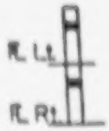

STRUCTURE NUMBER
Inv Elev.
Top Elev.
Inv Elev.
STATIONING

X. Utility and service symbols

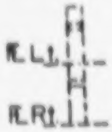
(NOTE: Give number of wires, owner's name, and address.)

Overhead power (cross bar perpendicular to ℄)	ϕ ϕ
Overhead telephone (cross bar parallel to ℄)	—⊖— —⊖—
Joint ownership poles	—⊕— —⊕—
Power or telephone overhead (when line crosses ℄	—ϕ— ----ϕ
Power underground	— P·U·G —
Telephone underground	— T·U·G —
Power manhole	Ⓟ
Telephone manhole	Ⓣ
Oil line	— O — O —
Water line	— W — W —
Gas line	— G — G —
Water meter	o— W.M.
Gas meter	o— G.M.
Fire hydrant	ȸ— F.H.
Valve	ō
Water well	◎
Storm sewer and manhole	═○═ ═○═
Sanitary sewer	→S.S. ——→S.S. ——→ (size and type)

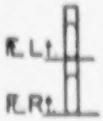
New 90° box



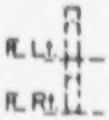
Exist. 90° box



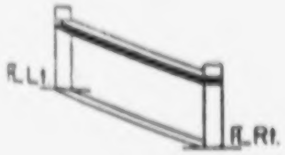
New 90° pipe



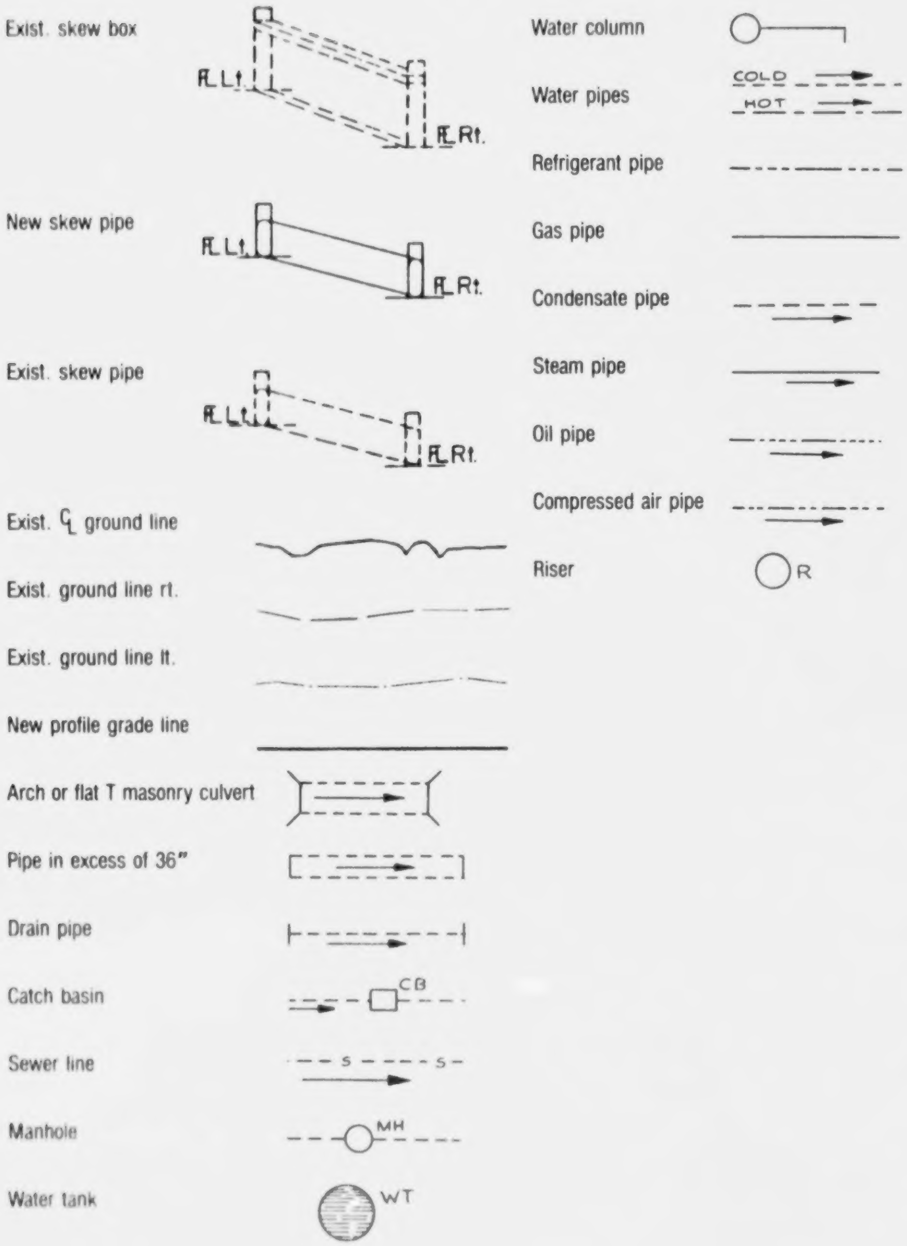
Exist. 90° pipe



New skew box

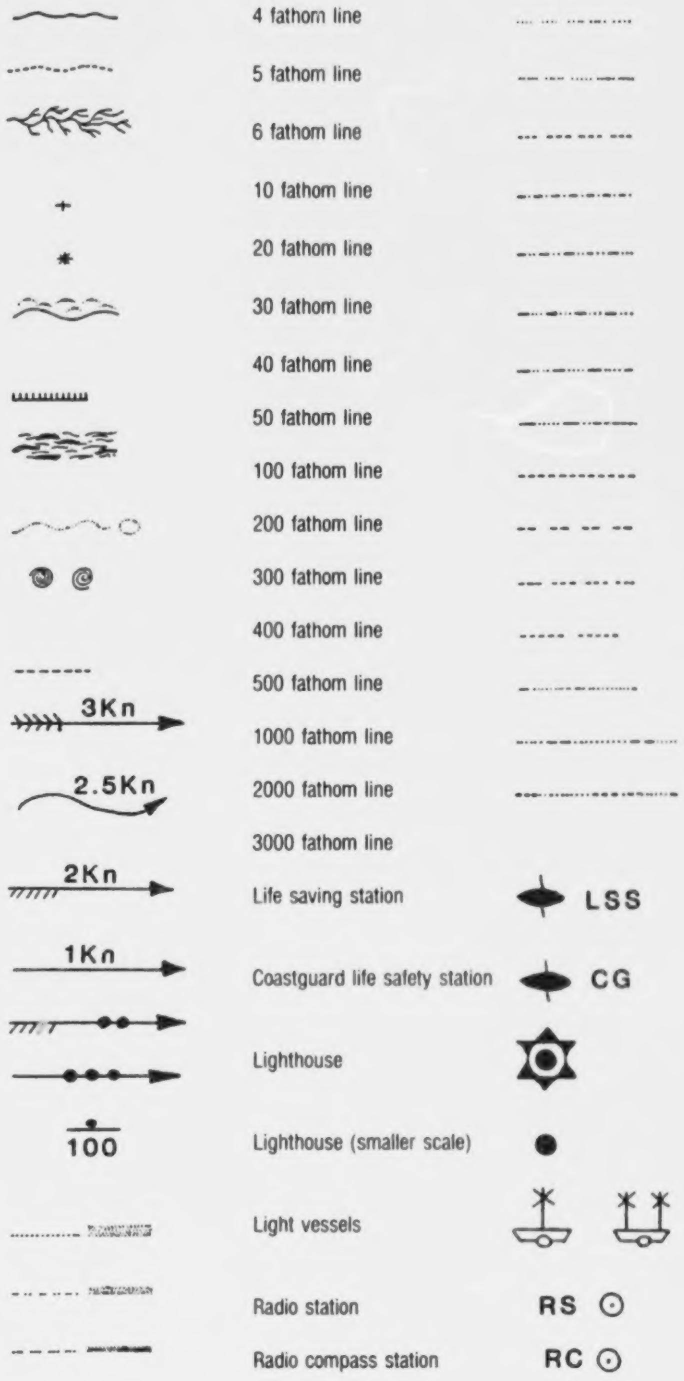


INFORMATION SHEET


Exist. skew box
FL Lt.
FL Rt.
New skew pipe
FL Lt.
FL Rt.
Exist. skew pipe
FL Lt.
FL Rt.
Exist. ℄ ground line
Exist. ground line rt.
Exist. ground line lt.
New profile grade line
Arch or flat T masonry culvert
Pipe in excess of 36"
Drain pipe
Catch basin
CB
Sewer line
S
S
Manhole
MH
Water tank
WT
Water column
Water pipes
COLD
HOT
Refrigerant pipe
Gas pipe
Condensate pipe
Steam pipe
Oil pipe
Compressed air pipe
Riser
R

INFORMATION SHEET

XI. Hydrographic and navigation symbols



Surveyed shore line	
Unsurveyed shore line	
Kelp or eel grass	
Rock underwater	+
Rock awash	✱
Breakers along shore	
Fishing stakes	
Overfalls and tide rips	
Limiting danger line	
Whirlpools and eddies	
Cable	
Non-tidal current 3 knots	3Kn
Non-tidal current (special use)	2.5Kn
Tidal currents flood 2 knots	2Kn
Tidal currents ebb 1 knot	1Kn
Tidal currents flood 2nd hour	
Tidal currents ebb 3rd hour	
No bottom at 100 fathoms	100
DEPTH CURVERS	
1 fathom or 6 foot line	
2 fathom or 12 foot line	
3 fathom or 18 foot line	

4 fathom line	
5 fathom line	
6 fathom line	
10 fathom line	
20 fathom line	
30 fathom line	
40 fathom line	
50 fathom line	
100 fathom line	
200 fathom line	
300 fathom line	
400 fathom line	
500 fathom line	
1000 fathom line	
2000 fathom line	
3000 fathom line	
Life saving station	LSS
Coastguard life safety station	CG
Lighthouse	
Lighthouse (smaller scale)	●
Light vessels	
Radio station	RS ⊙
Radio compass station	RC ⊙

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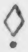
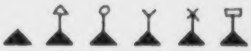
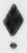
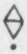
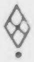
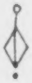
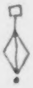
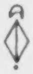
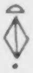
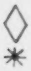
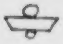
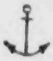
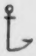
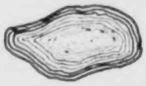
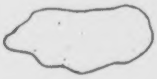
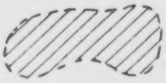
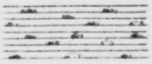
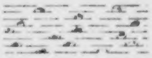
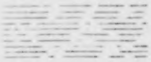
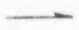
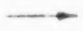
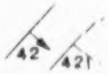
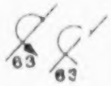
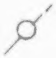
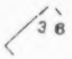
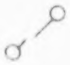
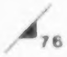
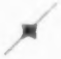
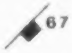
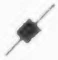
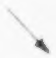
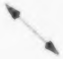
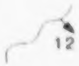
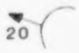
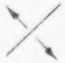
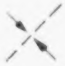
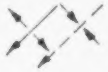
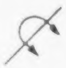
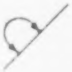
Radio tower	RT ⊙
Radio beacon	RBn ⊙
Water gage	
Lighted beacon	
General or red buoy	
Not lighted beacon	
Black buoy	
Horizontal striped buoy	
Horizontally striped (black & red) buoy	
Vertically striped buoy	
Checkered buoy	
Perch & ball buoy	
Perch & square buoy	
Whistling buoy	
Bell buoy	
Lighted buoy	
Mooring buoy	
Anchorage	
Small vessel anchorage	
Pond	
Salt pond	
Intermittent pond	
Salt marsh	
Fresh marsh	
Tidal flat	

INFORMATION SHEET

XII. Geological structure symbols

Direction	
Attitude	
Strike & dip of beds (arrow used in detailed maps)	
Strike & dip of overturned beds	
Strike of vertical beds	
Horizontal beds	
Strike & dip of cleavage (slate)	
Strike of vertical cleavage (slate)	
Horizontal cleavage (slate)	
Strike & dip of schistosity or foliation	
Strike of vertical schistosity or foliation	
Horizontal schistosity	
Strike & dip of joint plane	
Strike of vertical joint plane	
Horizontal joint plane	

Direction of pitch of linear parallelism, flow lines, linear stretching, or alignment of minerals & inclusions	
Direction of horizontal linear element	
General strike & dip of minutely folded beds	
Direction of pitch of minor folds (nature of isoclinal fold at its plunging end)	
Axis of anticline	
Axis of syncline	
Pitch of axis of anticline or syncline	
Axis of overturned or recumbent anticline (showing direction of inclination of axial plane	
Axis or overturned or recumbent syncline (showing direction of inclination of axial plane)	
Known fault	———
Known fault (approximate location)	— — — —
Doubtful or hypothetical fault	—?—?—

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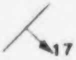
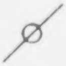
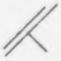
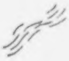
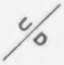
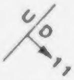
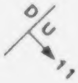
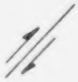
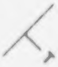
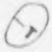
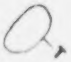
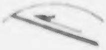
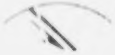
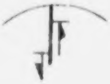
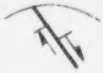
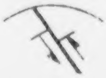
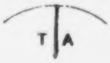
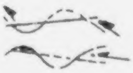
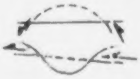
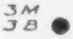
Concealed fault covered by later deposits (known or hypothetical)	- - - - - - -
Dip of fault plane	
Vertical fault plane	
Shear zone strike & dip	
Shear zone	
U-upthrow, high-angle fault, D-downthrow, high angle fault	
Normal fault	
Reverse fault	
Direction of horizontal movement in shear fault, tear fault, or flaw	
Overthrust, low-angle fault; T, overthrust side	
Klippe or outlier remnant of low angle fault plate; T, overthrust side	

Window, fenster, or hole in overthrust plate; T, overthrust side	
Overthrust; low-angle fault fault; arrow is directional movement of active block	
Underthrust; low-angle fault, arrow is directional movement of active block	
Vertical; high angle fault (arrow shows directional movement)	
Normal fault; high angle fault (arrow shows directional movement)	
Reverse fault; high angle fault (arrow shows directional movement)	
Horizontal movement in shear or tear fault (A-movement away from observer, T-movement toward observer)	
Klippe	
Window or fenster	

XIII. Oil and gas symbols

Location, rig or drilling well	○
Location, rig or drilling well, abandoned	
Location, rig or drilling well, number	
Oil well	●

Oil well, abandoned	
Oil well, number	
Oil well, volume	
Small oil well	

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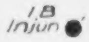
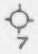
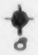
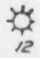
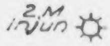
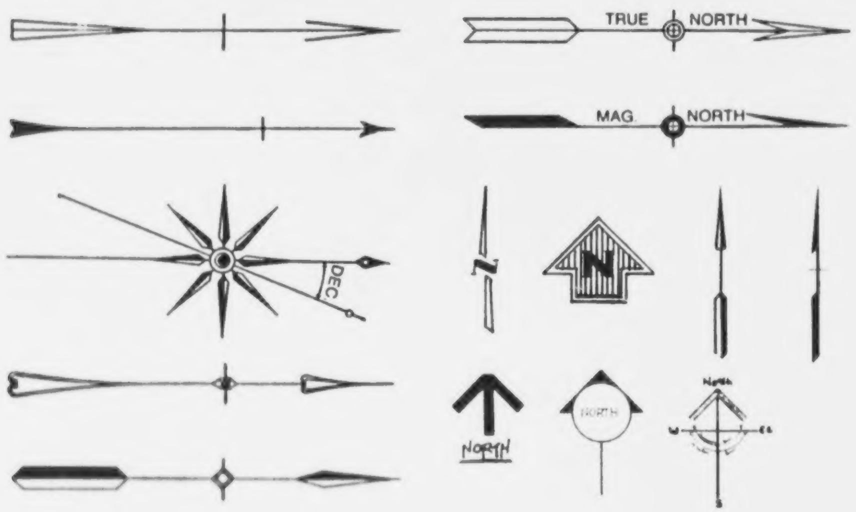
Small oil well, abandoned	
Small oil well, number	
Small oil well, volume	
Salt well	
Dry hole	
Dry hole, abandoned	
Dry hole, number	
Dry hole with showing of oil	
Dry hole with showing of oil, abandoned	
Dry hole with showing of oil, number	
Gas well	
Gas well, abandoned	
Gas well, number	
Gas well, volume	
Gas well with showing of oil	
Gas well with showing of oil, abandoned	

XIV. North arrow symbols


TRUE
NORTH
MAG.
NORTH
DEC
N
N
NORTH
NORTH
North
W
E
S

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XV. **General rules for drawing map symbols**

A. Should be easy to read and understand

B. Should conform to the general design and purpose of the drawing

C. Should follow standard and acceptable formats

D. Should assume as much as possible the form of the actual object it represents

E. Should never crowd a map

Example: Too many symbols for grass

F. Number of symbols included on a map is limited by the scale of the map.

G. Regardless of the scale of the map, symbols are drawn essentially the same size. They must be large enough for reproduction at present and final scale.

(NOTE: It is the judgment of the civil drafter and engineer to enlarge or emphasize the symbol according to priority of information shown on the map.)

H. Prominence of a symbol over another is achieved by variation in the line weight of the symbol.

(NOTE: The purpose of the map will determine which symbol is made prominent.)

I. Symbols repeated on a map need to be drawn identical to each other.

J. For all symbols that have a definite base such as grass and marsh, this base should be drawn parallel to the bottom of the sheet. (Never parallel to roadway and streams.)

K. Good rule to follow in proportioning a map would be to draw the important symbols first and work toward the least important features.

XVI. **Methods used in drawing symbols**

A. Freehand, such as woods, streams, material symbols

B. Template for specific mapping symbols

C. Stick up sheets

D. Pressure-sensitive transfers

E. CAD — Use of menu symbols to place repetitive symbols

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XVII. **Colors of map symbols**

A. Black — Cultural features, boundaries, lettering and notations

B. Blue — Water features such as seas, oceans, lakes, rivers, and canals; dark blue may be used for drainage systems

C. Brown — Contours, sand, washes, and topographic relief

D. Green — Vegetation such as trees, shrubs, orchards, and vineyards

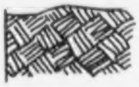
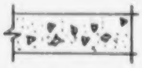
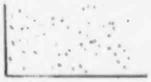
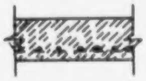
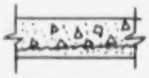
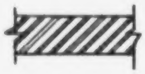
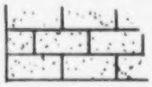
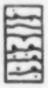
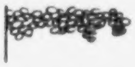
E. Yellow — Additional boundaries and distributional tones

F. Red — Important roads, public land and land grants, subdivisions, and field lines

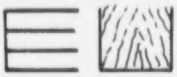
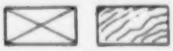
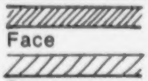
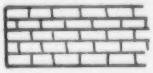
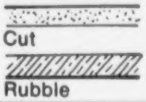
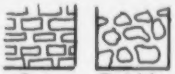
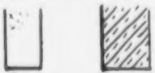
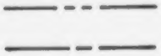
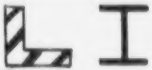
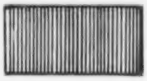
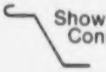
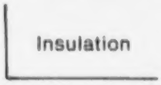
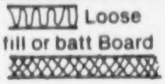
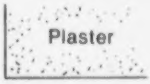
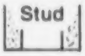
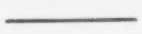
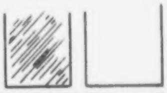
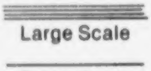
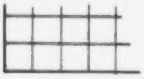
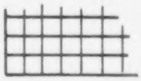
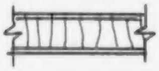
G. Gray — Shading and hatch marks

H. Purple — Office revisions from aerial photographs

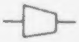
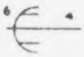
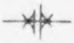
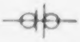
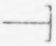
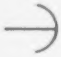
XVIII. **Common material symbols used in structural and architectural drawings**

MATERIAL	PLAN	ELEVATION	SECTION
Earth	None	None	
Plain concrete			Same as plan view
Concrete reinforced with bars			Same as plan view
Concrete reinforced with mesh			Same as plan view
Concrete block			
Gravel Fill	Same as section	None	

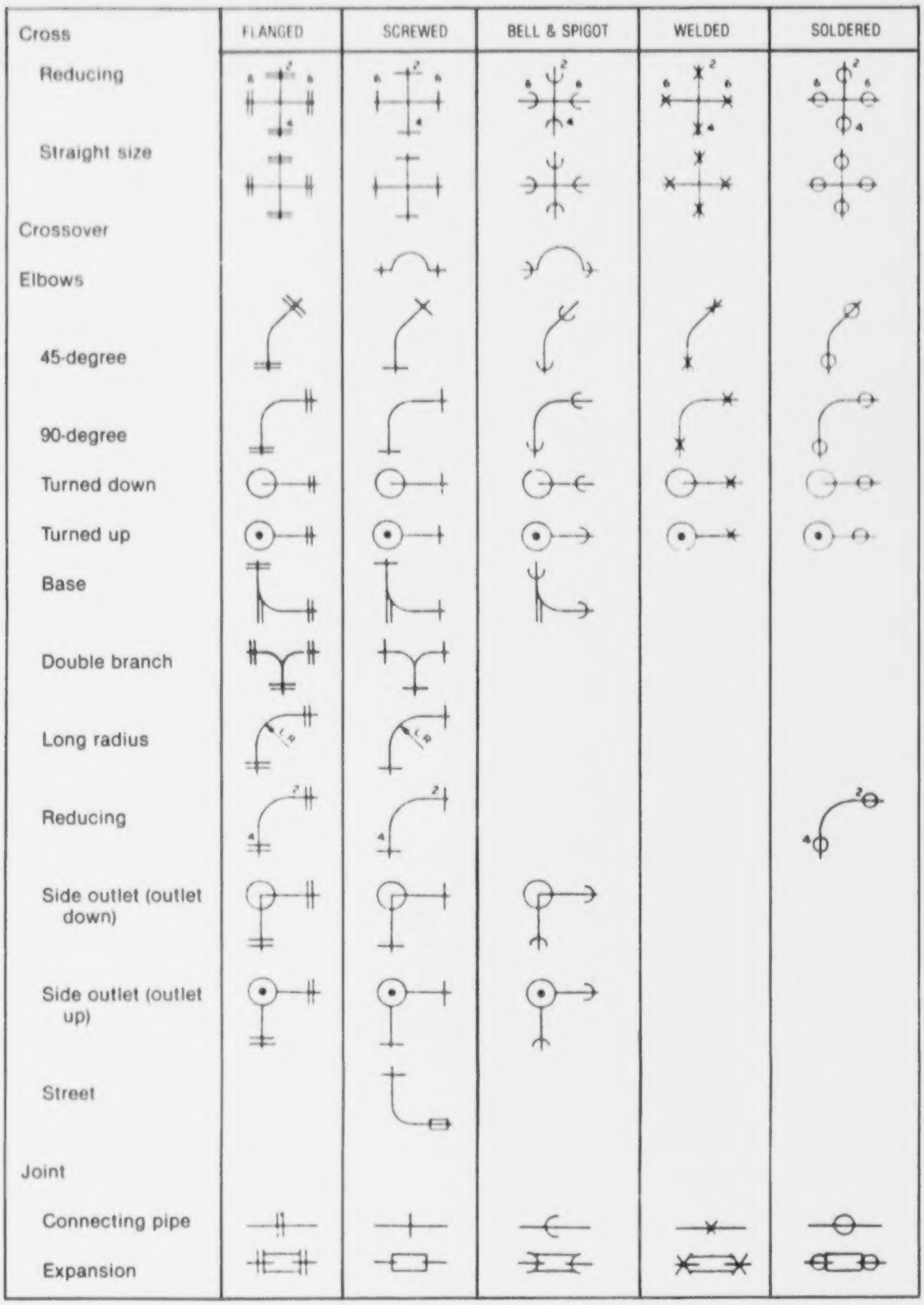
INFORMATION SHEET

MATERIAL	PLAN	ELEVATION	SECTION
Wood	Floor areas left blank		
Brick	 Face Common	 Face or common	Same as plan view
Stone	 Cut Rubble	 Cut Rubble	 Cut Rubble
Structural Steel		Indicate by note	 Specify
Sheet metal Flashing	Indicate by note		 Show Contour
Insulation	Same as section	 Insulation	 Loose fill or batt Board
Plaster	Same as section	 Plaster	 Stud Lath and plaster
Glass			 Large Scale Small Scale
Tile			

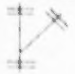
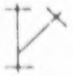
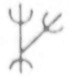
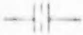
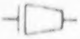
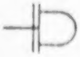
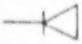
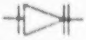
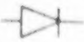
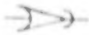
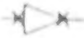
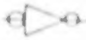
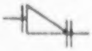
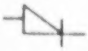
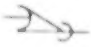
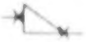
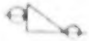
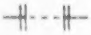
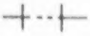
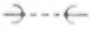
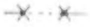
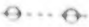
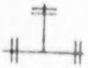
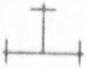
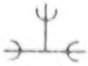
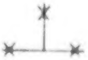
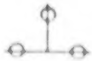
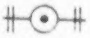
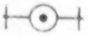
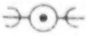
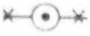
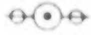
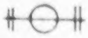
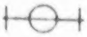
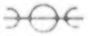
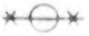
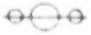
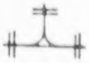
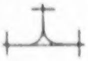
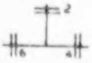
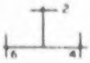
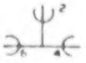
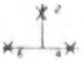
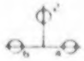
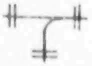
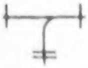
XIX. Standard symbols for pipe fittings

	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
Bushing					
Cap					

INFORMATION SHEET


FLANGED
SCREWED
BELL & SPIGOT
WELDED
SOLDERED
Cross
Reducing
Straight size
Crossover
Elbows
45-degree
90-degree
Turned down
Turned up
Base
Double branch
Long radius
Reducing
Side outlet (outlet down)
Side outlet (outlet up)
Street
Joint
Connecting pipe
Expansion
2
6
4
LR

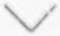
INFORMATION SHEET

	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
Lateral					
Orifice flange					
Reducing flange					
Plugs					
Bull plug					
Pipe plug					
Reducer					
Concentric					
Eccentric					
Sleeve					
Tee					
Straight size					
Outlet up					
Outlet down					
Double sweep					
Reducing					
Single sweep					

INFORMATION SHEET

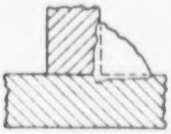
XX. **Welding symbols and their applications** (Transparency 1)

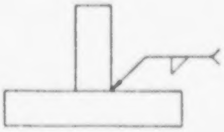
A. Common welds and their symbols

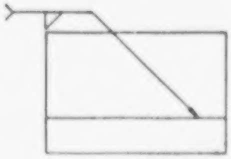
1. Bead
2. Fillet
3. Groove
    - a. Square
    - b. V 
    - c. Bevel
    - d. U
    - e. J

B. Applications of welding symbols

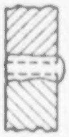
1. Fillet, arrow-side

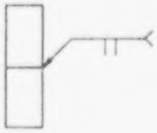


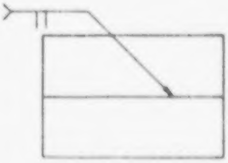




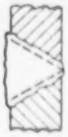
2. Square groove, arrow-side

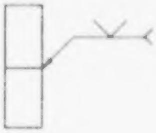


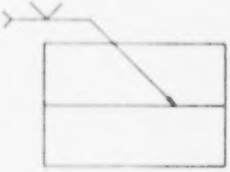




3. V groove, other side

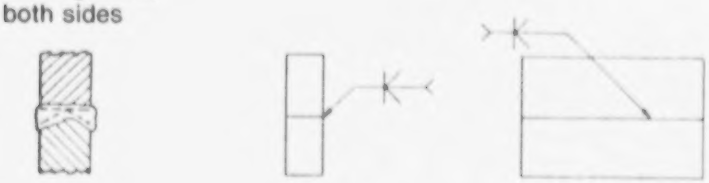




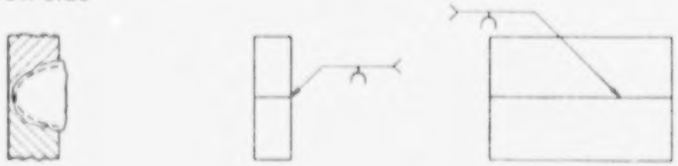


INFORMATION SHEET

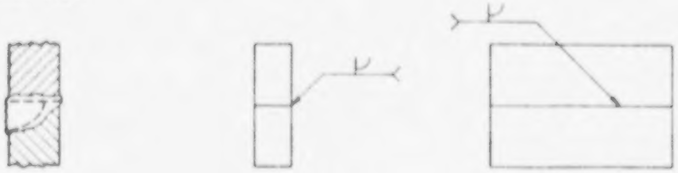
4. Bevel groove,
   both sides



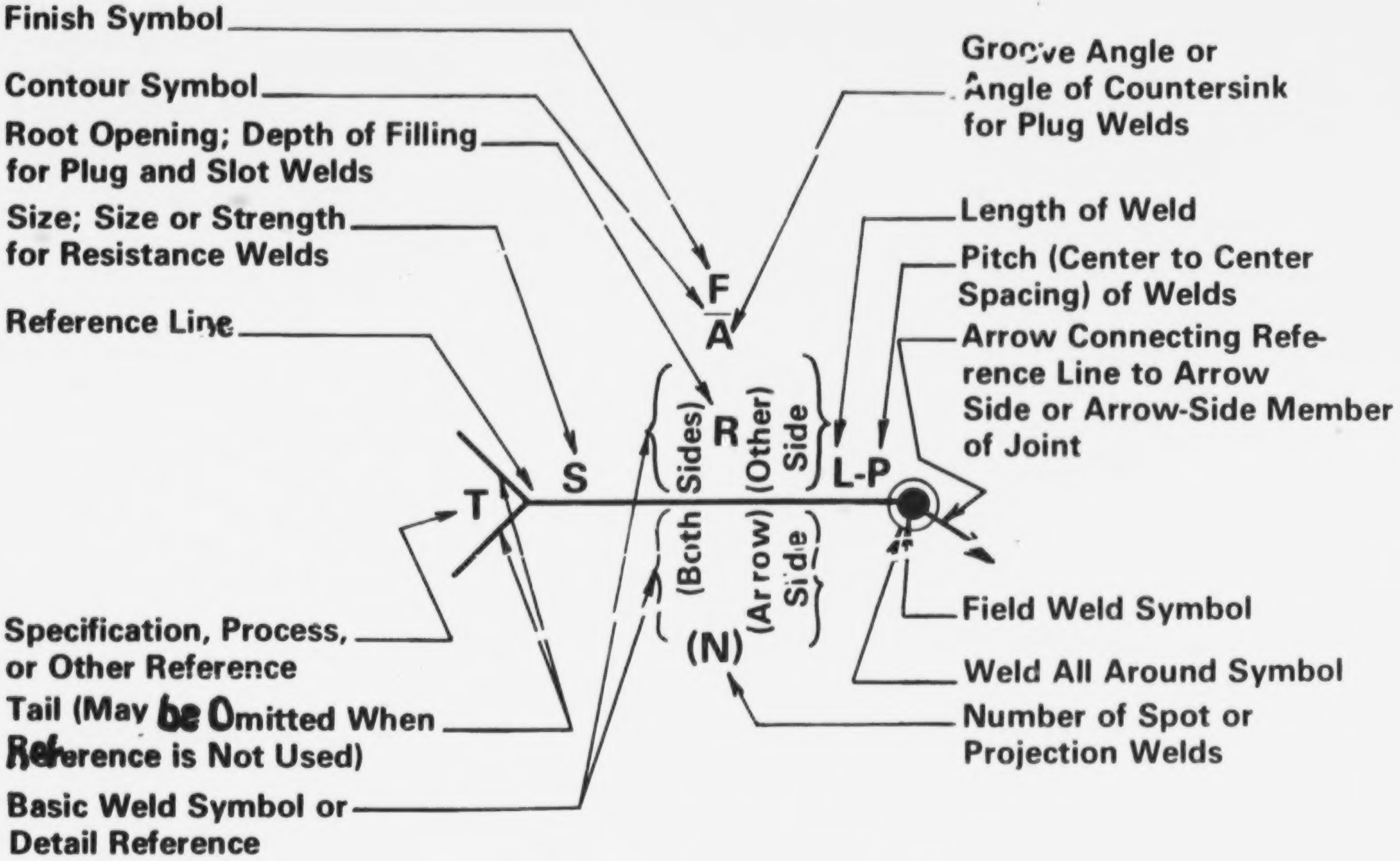
5. U groove,
   arrow-side



6. J groove,
   other side



Parts of a Welding Symbol



Finish Symbol

Contour Symbol

Root Opening; Depth of Filling for Plug and Slot Welds

Size; Size or Strength for Resistance Welds

Reference Line

Specification, Process, or Other Reference

Tail (May be Omitted When Reference is Not Used)

Basic Weld Symbol or Detail Reference

Groove Angle or Angle of Countersink for Plug Welds

Length of Weld

Pitch (Center to Center Spacing) of Welds

Arrow Connecting Reference Line to Arrow Side or Arrow-Side Member of Joint

Field Weld Symbol

Weld All Around Symbol

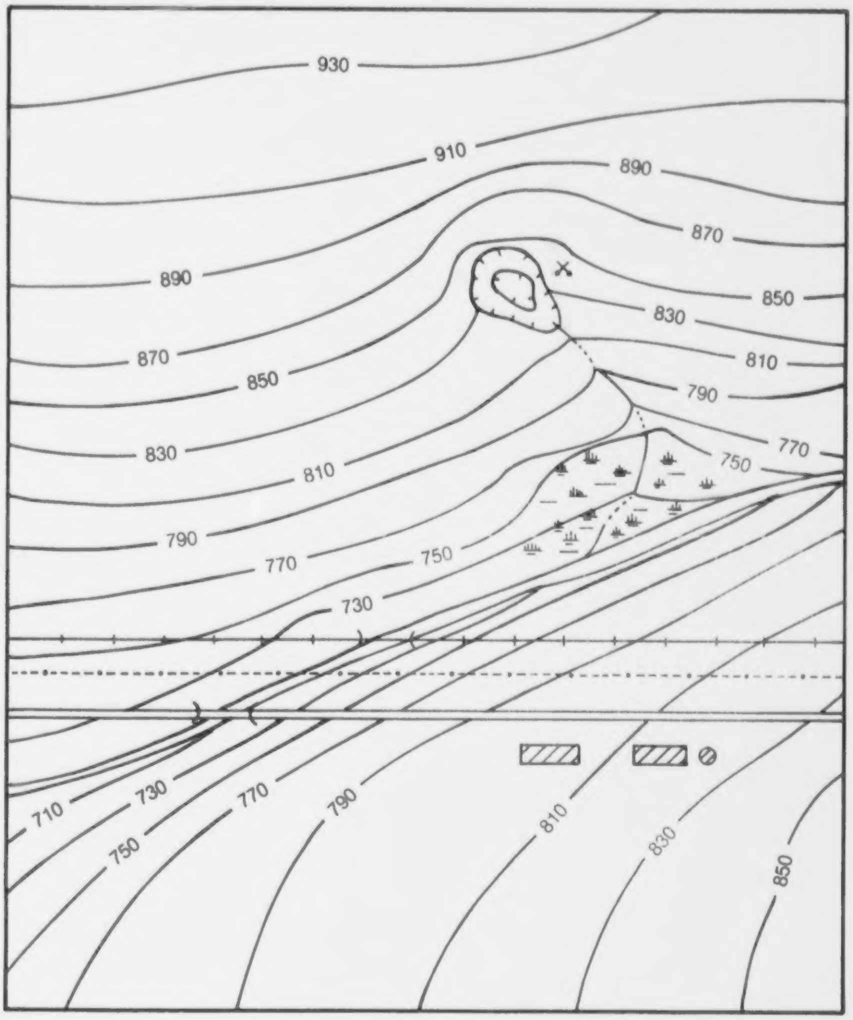
Number of Spot or Projection Welds

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

ASSIGNMENT SHEET #1 — SET UP A MAP LEGEND

Directions: Using the provided topographic map, find the symbol used to describe features and set up a legend for this map. Ask your instructor for the size of paper and tools to use (pencil or ink).

Suggested format: 8 1/2 × 11 film, ink, and Leroy lettering.


930
910
890
870
890
850
830
810
870
850
790
830
810
770
750
790
770
750
730
710
730
770
790
750
810
830
850

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

ASSIGNMENT SHEET #2 — LOCATE AND IDENTIFY SYMBOLS AND FEATURES ON A U.S.G.S. MAP

Directions: Identify each symbol called for on this portion of U.S.G.S. 7.5-minute quadrangle map. Turn the page for h.-o.

A. ______________________

B. ______________________

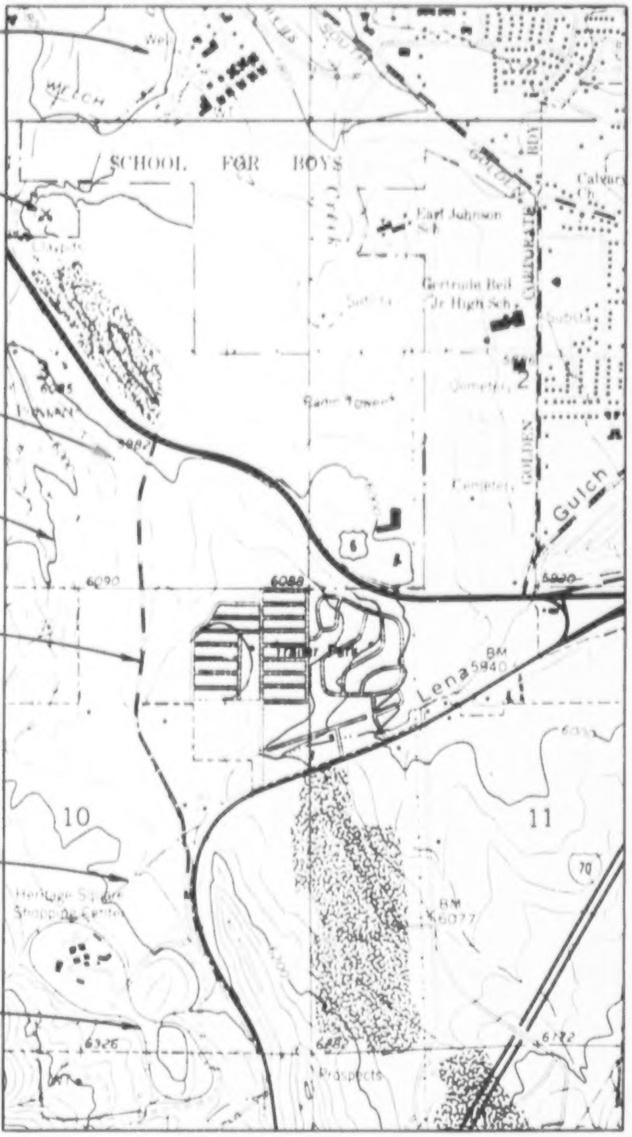
C. ______________________

D. ______________________

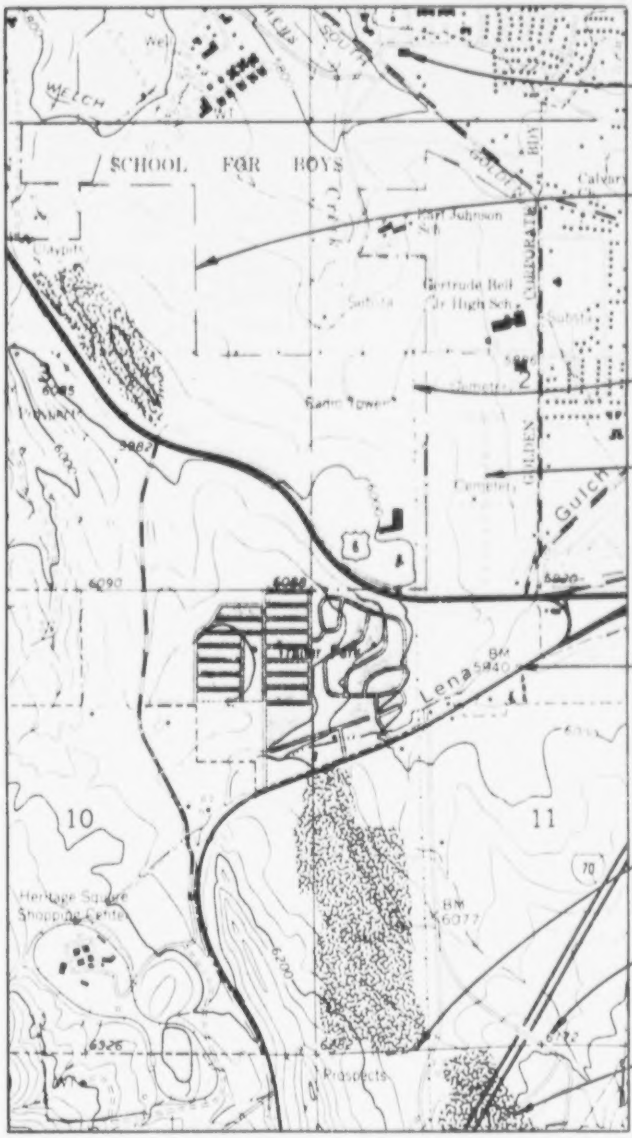
E. ______________________

F. ______________________

G. ______________________


Well
Gulch
SCHOOL FOR BOYS
Creek
Earl Johnson Sch
Gertrude Bell Jr High Sch
Calvary Ch
GOLDEN
Substa
Radio Towers
Cemetery
Cemetery
Gulch
6085
6082
6
6090
6088
5920
Trailer Park
Lena
BM 5940
10
11
70
Heritage Square Shopping Center
BM 6077
6326
6482
Prospects
6172

ASSIGNMENT SHEET #2


Welch
WELCH
SCHOOL FOR BOYS
Creek
Earl Johnson Sch
Calvary
Claypits
Gertrude Bell Jr High Sch
Substa
CORPORATE BDY
GOLDEN
Radio Tower
Cemetery
Gulch
6
Trailer Park
Lena
BM 5940
10
11
70
Heritage Square Shopping Center
BM 6077
6200
6326
Prospects

H. ______________________

I. ______________________

J. ______________________

K. ______________________

L. ______________________

M. ______________________

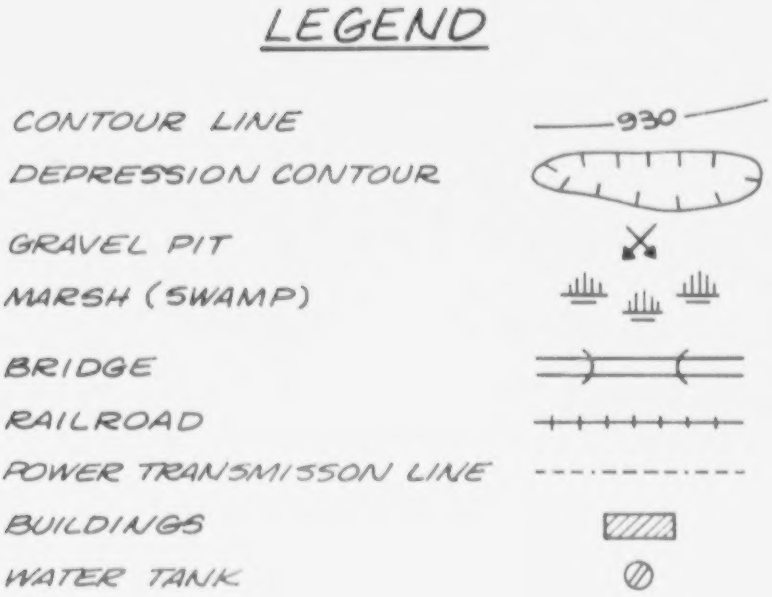
N. ______________________

O. ______________________

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1


LEGEND
CONTOUR LINE
930
DEPRESSION CONTOUR
GRAVEL PIT
MARSH (SWAMP)
BRIDGE
RAILROAD
POWER TRANSMISSON LINE
BUILDINGS
WATER TANK

Assignment Sheet #2

A. Well symbol
B. Clay pit
C. Spot elevation
D. Index contour
E. Secondary road
F. Stream
G. Railroad
H. Building
I. Reservation boundary
J. Power transmission line
K. Unimproved road
L. Bench mark
M. Section line
N. Section contour
O. Gravel

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

NAME ______________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. The structure and composition of the earth's crust

_____b. Method of charting waters which affords a channel for useful commerce or travel

_____c. Man-made features such as railroads, bridges, roads, and public utilities

_____d. A diagram, design, letter, or abbreviation which by convention or reference to a legend is understood to represent a specific characteristic or object

_____e. A description, explanation, table of symbols, and other information which is printed on a map or chart for better understanding and interpretation

_____f. Showing the details of a map in plan view

_____g. A line of demarcation between adjoining parcels of land

_____h. Features on a map such as lakes, streams, terrain, and vegetation

_____i. The relationship existing between a distance on a map and the corresponding distance on the earth

_____j. Features along the shore and the submerged parts of bodies of water

1. Boundary
2. Cultural features
3. Geological
4. Hydrographic features
5. Legend
6. Map scale
7. Natural land features
8. Navigation
9. Planimetry
10. Symbol

2. List four common types of symbols used in civil drafting.

a. ____

b. ____

c. ____

d. ____

TEST

3. State the correct abbreviations for the following words commonly used in civil drafting.

a. Access ______
b. Altitude ______
c. Approach ______
d. Area ______
e. Average ______
f. Base line ______
g. Bench mark ______
h. Bridge ______
i. Ceiling ______
j. Checked ______
k. Concrete ______
l. Cross road ______
m. Curb and gutter ______
n. Diagonal ______
o. East ______
p. Elbow ______
q. End to end ______
r. Equipment ______
s. Expansion joint ______
t. External ______
u. Foundation ______
v. Gravel ______
w. Highway ______
x. Joint ______
y. Lateral ______
z. Material ______
aa. Meridian ______
bb. National ______
cc. North ______
dd. Not to scale ______
ee. Original ______
ff. Pavement ______
gg. Plan and profile sheet ______
hh. Railroad ______
ii. Reference point ______
jj. Right-of-way ______
kk. River . ______
ll. Section line ______
mm. Shored ______
nn. Steel ______
oo. Survey ______
pp. Topography ______

4. Select the following true statements concerning factors that determine when an abbreviation should be used by placing an "X" in the appropriate blanks.

______a. Use an abbreviation when necessary to save time and space.

______b. Use an abbreviation only when the meaning is unquestionably clear to the intended reader.

______c. Use your own shortened versions of abbreviations as desired.

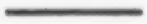
5. State two purposes of symbols on maps.

a. ____

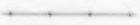
b. ____

TEST

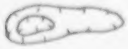
6. Identify the following U.S.G.S. topographic map symbols.



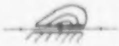
a. ______________________________



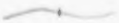
b. ______________________________



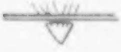
c. ______________________________



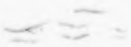
d. ______________________________



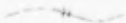
e. ______________________________



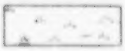
f. ______________________________



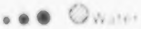
g. ______________________________



h. ______________________________

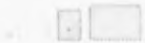


i. ______________________________

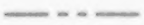


j. ______________________________

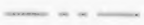
k. ______________________________



l. ______________________________



m. ______________________________



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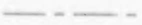
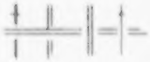
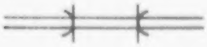


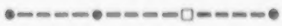
o. ______________________________



p. ______________________________



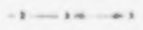
q. ______________________________

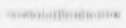


r. ______________________________

TEST

7. Identify the following other conventional topographic symbols.


a. ______________________________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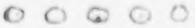
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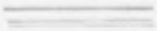
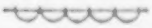

d. ______________________________

e. ______________________________

f. ______________________________

8. Identify the following boundary, fence, and track fixture symbols.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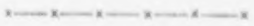
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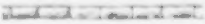
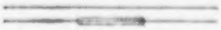

c. ____________________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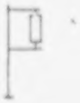
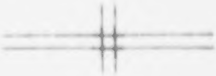
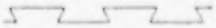
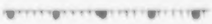

e. ____________________


f. ____________________


g. ____________________


h. ____________________

TEST

9. Match the civil symbols on the right with the correct meanings.

_____a. Highway bridge (general symbol)

_____b. Footbridge

_____c. Steel truss bridge

_____d. Suspension bridge

_____e. Arch bridge

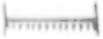
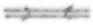
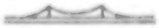
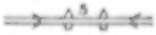
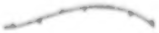
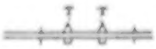
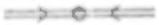
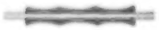
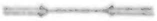
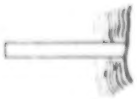
_____f. Pontoon bridge

_____g. Dam

_____h. Telephone line

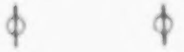
_____i. Highway drawbridge

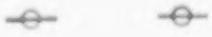
_____j. Pier

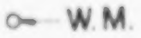
1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 

TEST

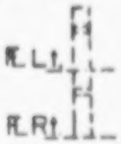
10. Identify the following utility and service symbols.

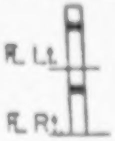


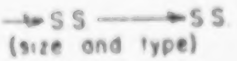




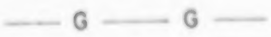
a. ______________ b. ______________ c. ______________

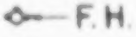


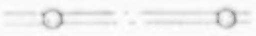



S S
S S
(size and type)

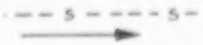
d. ______________ e. ______________ f. ______________

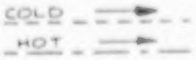


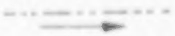




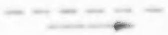
g. ______________ h. ______________ i. ______________

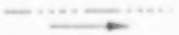


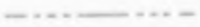




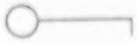
j. ______________ k. ______________ l. ______________

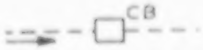






m. ______________ n. ______________ o. ______________





p. ______________ q. ______________

TEST

11. Match hydrographic and navigation symbols with the correct meanings.

______a. Non-tidal current

______b. Tidal currents flood

______c. Tidal currents ebb 3rd hour

______d. Surveyed shore line

______e. Unsurveyed shore line

______f. Kelp or eel grass

______g. Life saving station

______h. Lighthouse

______i. General or red buoy

______j. Lighted buoy

______k. Lighted beacon

______l. Not lighted beacon

______m. Whirlpools and eddies

______n. Pond

______o. 1 fathom or 6′ line

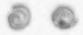
______p. 4 fathom line

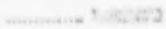
______q. 10 fathom line

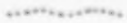
______r. 40 fathom line

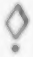
______s. 100 fathom line

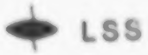
______t. 400 fathom line

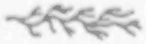
1. 

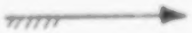
2. 

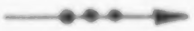
3. 

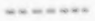
4. 

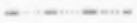
5. 

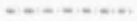
6. 

7. 

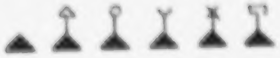
8. 

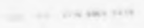
9. 

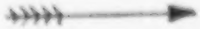
10. 

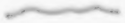
11. 

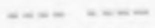
TEST

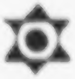
12. 

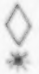
13. 

14. 

15. 

16. 

17. 

18. 

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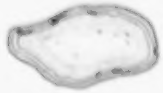
20. 

TEST

12. Match the geological structure symbols on the right with the correct meanings.

______a. Direction

______b. Altitude

______c. Horizontal beds

______d. Horizontal cleavage

______e. Horizontal joint plane

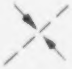
______f. Axis of anticline

______g. Axis of syncline

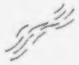
______h. Known fault

______i. Shear zone

______j. Normal fault

1. 

2.

3. 

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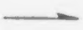
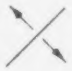
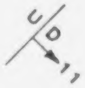
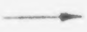
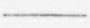
5. 

6. 

7. 

8. 

9. 

10.

TEST

13. Complete the following chart of oil and gas symbols and their meanings.

Location, rig or drilling well	a.______	Dry hole	f.______
Oil Well	b.______	Dry hole, abandoned	g.______
Oil Well, abandoned	c.______	Dry hole with showing of oil, number 8	h.______
d.______________		i.______________	
e.______________		j.______________	

14. Draw three examples of north arrow symbols in the space below.

15. Select the following true statements concerning general rules for drawing map symbols by placing an "X" in the appropriate blanks.

_____a. Should be difficult to read so only the engineer can understand

_____b. Should conform to the general design and purpose of the drawing

_____c. Do not follow standard formats

_____d. Should assume as much as possible the form of the actual object it represents

_____e. Should be used excessively, even if they crowd the map

_____f. Number of symbols included on a map is limited by the scale of the map.

TEST

______g. On large scale maps, all symbols are drawn much larger.

______h. Prominence of a symbol over another is achieved by variation in the shading and color usage

______i. Symbols repeated on a map may be drawn differently for variety

______j. The base of a symbol (such as for grass) should be drawn parallel to the nearest roadway or stream

______k. Good rule to follow in proportioning a map would be to draw the important symbols first and work toward the least important features.

16. List three methods used in drawing symbols.

a. ____

b. ____

c. ____

17. Match color codes on the right with corresponding map symbols.

______a. Water features

______b. Vegetation

______c. Cultural features, boundaries, lettering and notations

______d. Contours, sand, washes, and topographic relief

______e. Shading and hatch marks

______f. Office revisions from aerial photographs

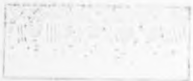
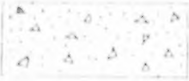
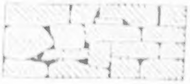
______g. Additional boundaries and distributional tones

______h. Important roads, public land and land grants, subdivisions, and field lines

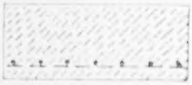
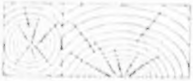
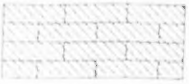
1. Red
2. Black
3. Yellow
4. Blue
5. Gray
6. Brown
7. Purple
8. Green

TEST

18. Identify the following common material symbols used in structural and architectural drawings.

a. ______ b. ______ c. ______

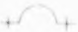
d. ______ e. ______ f. ______

19. Complete the following chart of standard symbols for pipe fittings by either drawing the required symbols or by stating the type of symbol shown **and** its method of connection.

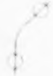
a. Bell & spigot cap ______

b. Flanged, straight size cross ______

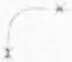
c. ______



d. ______



e. ______

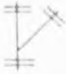


f. Screwed, double branch elbow ______

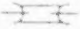
g. Screwed street elbow ______

h. Flanged, long radius elbow ______

i. ______

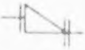


j. ______



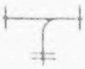
k. Welded concentric reducer ______

l. ______



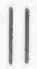
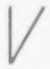
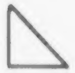
m. Bell & spigot straight size tee ______

n. ______

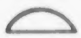
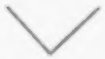
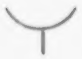


TEST

20. Identify the following common welding symbols.

a. ____________________ b. ____________________ c. ____________________

d. ____________________ e. ____________________ f. ____________________

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

21. Set up a map legend. (Assignment Sheet #1)

22. Locate and identify symbols and features on a U.S.G.S. map. (Assignment Sheet #2)

STANDARD SYMBOLS AND ABBREVIATIONS
UNIT III

ANSWERS TO TEST

1.
   a. 3
   b. 8
   c. 2
   d. 10
   e. 5
   f. 9
   g. 1
   h. 7
   i. 6
   j. 4

2. Any four of the following:
   a. Map symbols
   b. Drawing symbols
   c. Labels in the form of abbreviations
   d. Pipe symbols
   e. Weldment symbols
   f. Utility symbols
   g. Material symbols
   h. Oil and gas symbols

3.
   a. ACC
   b. ALT
   c. APPR
   d. *A*
   e. AVG
   f. BL or $\mathrm{B}\!\!\!\mathrm{L}$
   g. BM
   h. BR
   i. CLG
   j. CKD
   k. CONC
   l. X RD
   m. C & G
   n. DIAG
   o. E
   p. ELL
   q. E to E
   r. EQPT
   s. EXP JT
   t. EXT
   u. FDN
   v. GVL
   w. HWY
   x. JT
   y. LATL
   z. MTL
   aa. MER
   bb. NATL
   cc. N
   dd. NTS
   ee. ORIG
   ff. PVMT
   gg. P & P Sheet
   hh. RR
   ii. RP
   jj. R/W or ROW
   kk. R
   ll. SL or $\mathrm{S}\!\!\!\mathrm{L}$
   mm. SHO
   nn. STL
   oo. SURV
   pp. TOPO

4. a,b

5.
   a. To represent the location and identity of land features that are generally too large to be shown in detail on a map
   b. To help keep information on a map to a minimum and thereby avoid cluttering

ANSWERS TO TEST

6. a. Primary highway, hard surface
   b. Single track railroad
   c. Depression contours
   d. Cut
   e. Small falls
   f. Fill
   g. Intermittent streams
   h. Small rapids
   i. Marsh (swamp)
   j. Water tank
   k. Church
   l. Buildings
   m. U.S. land survey section line
   n. State boundary line
   o. County, parish, or municipal boundary line
   p. Road overpass and underpass
   q. Road bridge
   r. Power transmission line

7. a. Fence line
   b. Levee
   c. Trees
   d. Curb and gutter (proposed)
   e. School
   f. Manhole

8. a. Track pan
   b. Barbed wire fence
   c. Stone fence
   d. Single car retarder
   e. Mail crane
   f. Crossing
   g. Rail fence
   h. Picket fence

9.

9.	a.	2	f.	6
	b.	9	g.	1
	c.	4	h.	5
	d.	3	i.	7
	e.	8	j.	14

10. a. Overhead power
    b. Overhead telephone
    c. Water meter
    d. Existing 90° pipe
    e. New 90° box
    f. Sanitary sewer
    g. Gas line
    h. Fire hydrant

ANSWERS TO TEST

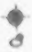
i. Storm sewer and manhole
j. Sewer line
k. Water pipes
l. Compressed air pipe
m. Condensate pipe
n. Oil pipe
o. Refrigerant pipe
p. Water column
q. Catch basin

11.

a.	14	k.	19
b.	7	l.	12
c.	8	m.	1
d.	15	n.	20
e.	3	o.	2
f.	6	p.	13
g.	5	q.	11
h.	17	r.	10
i.	4	s.	9
j.	18	t.	16

12.

a.	5	f.	6
b.	8	g.	1
c.	2	h.	9
d.	10	i.	3
e.	4	j.	7

13. a. ○
b. ●
c.
d. Small oil well
e. Small oil well, abandoned
f.
g.
h. 
i. Gas well
j. Salt well

14. Evaluated to the satisfaction of the instructor.

15. b,d,f,k

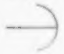
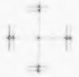
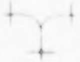
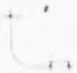
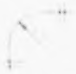
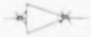
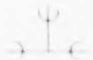
16. a. Freehand, such as woods, streams, material symbols
b. Template for specific mapping symbols
c. Stick up sheets
d. Pressure-sensitive transfers
e. CAD

17.

a.	4	e.	5
b.	8	f.	7
c.	2	g.	3
d.	6	h.	1

ANSWERS TO TEST

18. a. Earth
    b. Plain concrete
    c. Rubble stone
    d. Concrete reinforced with bars
    e. Finish wood
    f. Brick (face or common)

19. a. 
    b. 
    c. Screwed crossover
    d. Soldered 45° elbow
    e. Welded 90° elbow
    f. 
    g. 
    h. 
    i. Flanged lateral
    j. Bell & spigot expansion joint
    k. 
    l. Flanged eccentric reducer
    m. 
    n. Screwed, single sweep tee

20. a. Square groove
    b. Bevel groove
    c. Fillet
    d. Bead
    e. V groove
    f. U groove

21.-22. Evaluated to the satisfaction of the instructor

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the fundamentals of surveying, identify surveying equipment, reduce field notes, convert azimuth to bearing and bearing to azimuth, plot traverses by different methods, and mathematically close a traverse. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to interpretation of surveyor's notations with the correct definitions.
2. Complete statements concerning survey methods to determine distances and positions of points.
3. Identify types of horizontal and vertical angles.
4. Match principal surveying equipment with the correct uses.
5. Match types of surveys with descriptions of their uses.
6. Select true statements concerning stationing.
7. Complete statements concerning field notes.
8. Select true statements concerning the arrangement of field notes in the field book.
9. Match methods of recording field notes with the correct characteristics.
10. Identify examples of types of field notes.

OBJECTIVE SHEET

11. Complete statements concerning traverses.
12. Distinguish between a bearing and an azimuth.
13. State the formulas used to convert bearings to azimuths and azimuths to bearings.
14. Select true statements concerning common methods for plotting traverses.
15. Plot lines and distances using several methods. (Assignment Sheet #1)
16. Convert azimuths to bearings and bearings to azimuths. (Assignment Sheet #2)
17. Layout a closed traverse. (Assignment Sheet #3)
18. Complete a mathematical closure of a traverse. (Assignment Sheet #4)
19. Reduce four types of field notes. (Assignment Sheet #5)
20. Draw a map using bearings, distances, and coordinates. (Assignment Sheet #6)

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Observe a surveying field crew performing a survey.
2. Invite a speaker to come in to discuss the legal importance of field notes.
3. Visit an engineering supply firm to look at surveying equipment and field note books.
4. Show examples of the different types of drawings made in civil drafting as they correspond to the different types of surveys. (See Objective V.)
5. Do a small field survey to locate points of elevations and distances.
6. Use the field note examples in the Information Sheet, Objective X, for additional assignments on field note reduction.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1 — Measuring Horizontal Distances
2. TM 2 — Finding an Elevation with a Level and a Rod
3. TM 3 — Surveying Equipment
4. TM 4 — Surveying Equipment (Continued)
5. TM 5 — Styles of Field Note Paper
6. TM 6 — Initializing a Field Book
7. TM 7 — Types of Traverses
8. TM 8 — Direction by Bearing or Azimuth
9. TM 9 — Methods for Plotting Traverses
10. TM 10 — Methods for Plotting Traverses (Continued)
11. TM 11 — Methods for Plotting Traverses (Continued)

D. Assignment sheets

1. Assignment Sheet #1 — Plot Lines and Distances Using Several Methods
2. Assignment Sheet #2 — Convert Azimuths to Bearings and Bearings to Azimuths
3. Assignment Sheet #3 — Layout a Closed Traverse
4. Assignment Sheet #4 — Complete a Mathematical Closure of a Traverse
5. Assignment Sheet #5 — Reduce Four Types of Field Notes
6. Assignment Sheet #6 — Draw a Map Using Bearings, Distances, and Coordinates

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Glossaries of BLM Surveying and Mapping Terms*. 2nd ed. Bureau of Land Management/U.S. Department of the Interior, 1980.

B. *Definitions of Surveying and Associated Terms*. American Congress on Surveying and Mapping and the American Society of Civil Engineers, 1978.

C. Nelson, John A. *Drafting for Trades and Industry: Civil*. Albany, NY: Delmar Publishers, 1979.

D. Madsen, David and Terence Shumaker. *Civil Drafting Technology*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

E. *Map Drafting and Related Computations for Plane Surveying: Field Book*. Natchitoches, LA: Vocational Curriculum Development and Research Center, 1965.

F. McCormac, Jack C. *Surveying Fundamentals*. Englewood Cliffs, NJ 07632: Prentice-Hall, Inc., 1983.

G. Carey, Clifton O. *Mapping*. Scranton, PA: International Textbook Co., 1937.

H. Brinker & Wolf. *Elementary Surveying*, 7th ed. New York: Harper and Row, 1984.

I. Brown, Walter. *Drafting for Industry*. South Holland, IL: Goodheart-Wilcox Co., Inc., 1978.

J. Giachino, J.W., and H.J. Beukema. *Engineering Technical Drafting and Graphics*. 3rd ed. Chicago, IL 60637: American Technical Society, 1972.

K. Neunzert, Gaby. Unpublished class notes. Colorado School of Mine, Golden, CO.

L. Carbonneau, Charles. Unpublished class notes and assignments. Lake Area Vo-Tech Institute, Watertown, SD.

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

INFORMATION SHEET

I. **Terms and definitions**

A. Azimuth — The horizontal direction reckoned clockwise from the meridian plane.

B. Back bearing — Bearing of a station to a preceding station.

C. Beaman arc — A specially graduated arc attached to the vertical circle of an alidade or transit to simplify computing elevation difference for inclined stadia sights.

D. Bearing — The direction of the line expressed by the acute angle with respect to a reference meridian which can be north or south.

E. Bench mark — A relatively permanent material object, natural or artificial bearing a marked point whose elevation above or below an adopted datum is known.

F. Course — The bearing or azimuth and length of a line.

G. Datum — Any numerical or geometric quantity or set of such quantities which may serve as a reference or base for other quantities.

H. Elevation — The vertical distance from a datum, generally mean sea level, to a point or object on the earth's surface.

I. Grid — A series of measured parallel and perpendicular reference lines laid out an equal distance apart to form equal squares.

J. Horizontal angle — The difference in direction between two intersecting lines in a horizontal plane, two intersecting vertical planes, or two intersecting lines of sight.

K. Horizontal length — The straight line distance measured in a horizontal plane.

L. Hub — A substantially square stake, usually driven flush with the ground, with a tack marking the survey point.

M. Latitude and departure — The position of a point, line, traverse, triangulation, or grid can be defined by coordinates which are northerly or southerly (latitudes), measured from an arbitrarily chosen east-west (x) axis, and easterly and westerly (departures) measured from an arbitrarily chosen north-south (y) axis.

N. Monument — A physical structure, such as an iron post, marked stone, or tree in place, which marks the location of a corner point established by a cadastral survey.

INFORMATION SHEET

O. Station — Arbitrary points established in a survey usually located 100 feet apart.

(NOTE: An instrument setup point is often referred to as a station.)

P. Surveying — The science of determining the dimensions and contours of the earth's surface by measurements of distances, directions, and elevations; computations of areas and volumes; and the preparation of necessary maps.

Q. Traverse — A number of points (called traverse stations) connected in series between horizontal angles by horizontal lengths; may be open or closed.

R. Traversing — A surveying procedure used to determine the direction and length of a series of lines known as courses.

S. Triangulation — A series of connecting triangles in which a side of one and the angle of all are measured and the remaining sides are computed by trigonometry.

T. Vertical angle — The difference in direction between a horizontal plane and an intersecting line, plane, or a line of sight to a point.

U. Vertical length — A measurement of a difference in height or elevation.

II. **Survey methods to determine distances and positions of points** (Transparencies 1 and 2)

A. Determining distances — Four dimensions are measured.

1. Horizontal lengths — Measurements are made by direct or indirect methods.

   a. Direct method — By wheels, human pacing, or tapes.

   b. Indirect method — Stadia equipped instruments, graduated rods, electronic devices, or aerial photographs.

   (NOTE: The type of measurement and equipment used depends upon required accuracy, access to the line, and time and cost involved.)

2. Vertical lengths — Figured by trigonometry, barometric pressures, and differential leveling

3. Horizontal angles

   a. Measured by transit or theodolite in the horizontal plane in degrees of arc.

   b. Usually measured in a clockwise direction.

4. Vertical angles — Measured in the vertical plane in degrees of arc.

INFORMATION SHEET

B. Determining horizontal positions — The horizontal positions of points are determined by the following:

1. Traversing

2. Triangulation

3. Grid

4. Azimuth and bearing

5. Latitude and departure

C. Determining vertical positions — The vertical positions of points are determined from a series of level readings and references to datum, elevation, and bench mark.

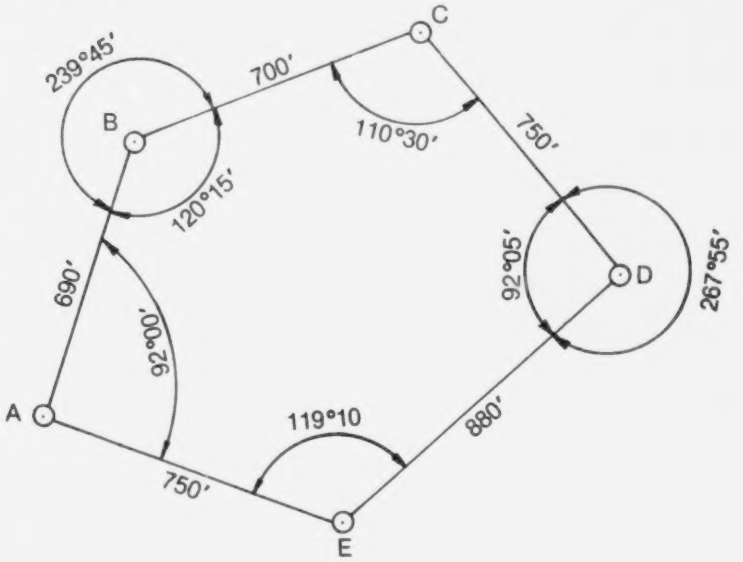
III. **Types of horizontal and vertical angles**

A. Horizontal angles

1. Interior angles — Measured angles on the inside of an enclosing figure (Figure 1)

2. Exterior angles — Measured angles on the outside of an enclosing figure (Figure 1)

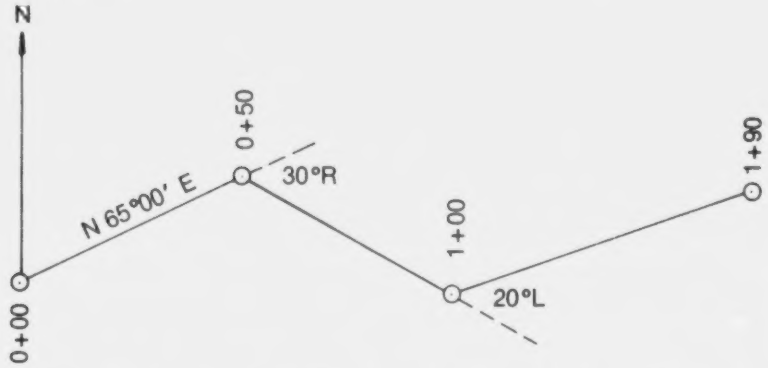
FIGURE 1



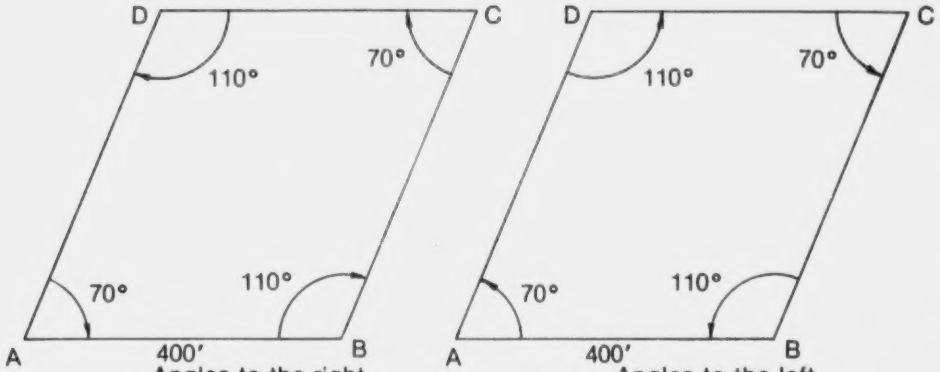
INFORMATION SHEET

3. Deflection angles — Measured angles right or left from an extension of the back line through the forward line (Figure 2)

FIGURE 2


N
0+50
30°R
N 65°00′ E
1+90
1+00
20°L
0+00

4. Angles to the right (clockwise) or angles to the left (counterclockwise) (Figure 3)


D
C
110°
70°
70°
110°
A
400′
B
D
C
110°
70°
70°
110°
A
400′
B

Angles to the right

Angles to the left

B. Vertical angles (Figure 4)

1. Plus (+) or minus (−) angles — Measured up (plus) or down (minus) from a horizontal line of projection

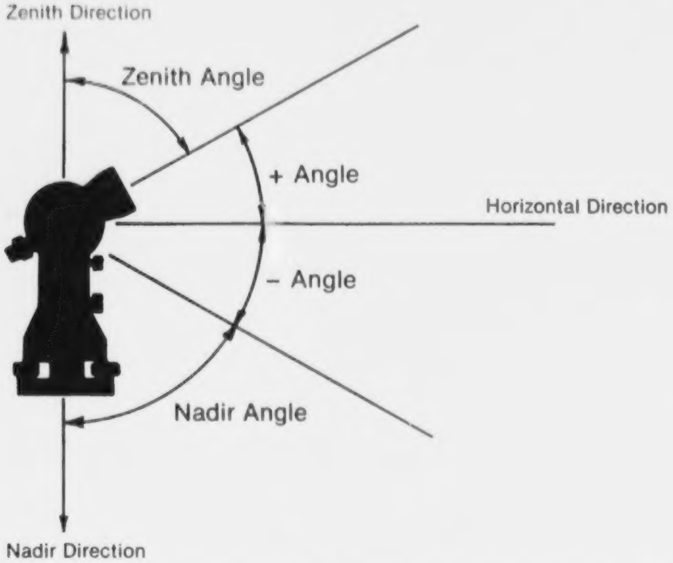
   (NOTE: Plus angles are sometimes called angles of elevation and minus angles may be called angles of depression.)

2. Zenith angle — Measured down from a point directly above the observer

INFORMATION SHEET

3. Nadir angle — Measured up from a point directly below the observer

FIGURE 4



IV. **Principal surveying equipment and their uses** (Transparencies 3 and 4)

A. Tapes — Used to measure horizontal distances; several types are used.

1. Steel tapes — 50 ft, 10 m
2. Metallic or woven tapes — Invar, nylon, steel
3. Chain — 100 ft, 200 ft, 300 ft, 30 m, 50 m, 100 m

B. Electronic distance meter (EDM) — Emits a signal of electromagnetic energy from a position to a receiver at another position. The signal is returned from the receiver to the instrument such that two times the distance between the two positions can be measured.

C. Levels — Used to establish the elevation of different points on the ground; several types used.

1. Dumpy level
2. Hand level
3. Self-leveling level

D. Level rod — A straight rod or bar with a flat face graduated in linear units with zero at the bottom, used in measuring the vertical distance between a point on the ground and the horizontal line of sight of a leveling instrument.

INFORMATION SHEET

E. Transit — Used primarily for measuring horizontal and vertical angles, prolonging and setting points in line, measuring approximate distances by the stadia principles, and for leveling operations.

F. Theodolite — Accomplishes the same tasks as a transit through optical means that are more accurate.

G. Planetable and alidade — Used for obtaining detail and topography.

H. Field books — Used for recording survey notes and layout and construction data.

V. **Types of surveys**

A. Land or boundary survey

1. Locates property corners and boundary lines.

2. Is normally a closed traverse because the survey always returns to the point of beginning (POB).

B. Topographic survey — Locates elevations and features on the land, both natural and artificial.

C. Geodetic survey

1. Is a survey covering large areas.

2. Is mapped by triangulation.

3. The control established by geodetic surveys is often used as references for other surveys.

D. Photogrammetric survey

1. Most large area surveys are now made using aerial photographs.

2. Photographs taken at various altitudes are the field notes for this survey.

3. Measurements are taken using a stereoplotter from the photos of known distances on the ground (established by a land survey or open traverse).

E. Route survey

1. Is an open traverse that is run when mapping linear features such as highways, pipelines, or power lines.

2. Does not close on itself.

INFORMATION SHEET

F. Construction survey

1. Is performed at a construction site.

2. Establishes building lines, elevations of excavations, fills, foundations, and floors.

VI. **Stationing**

A. Survey distances are recorded by stations.

B. Distance between full stations is 100 feet.

C. A fractional part of a full station is called a plus station.

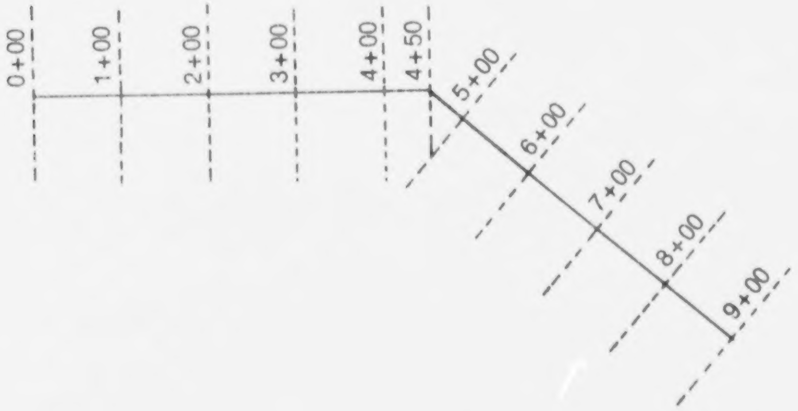
Example: A point on a line 309.20 beyond station 10 + 00 reads as:

$$\underset{\text{Number of full stations}}{13} + \underset{\text{Fractional part of a station}}{09.20}$$

(NOTE: Special care must be taken by the drafter to see what units [feet or meters] are being used.)

D. Beginning point in an open traverse is labeled station 0+00. (Figure 5)

FIGURE 5



(NOTE: It is recommended to not start the stationing at station 0+00 because later additional information may be required behind the starting point and working with negative stationing is cumbersome.)

INFORMATION SHEET

E. Station point set in the field by a survey crew typically has three stakes. (Figure 6)

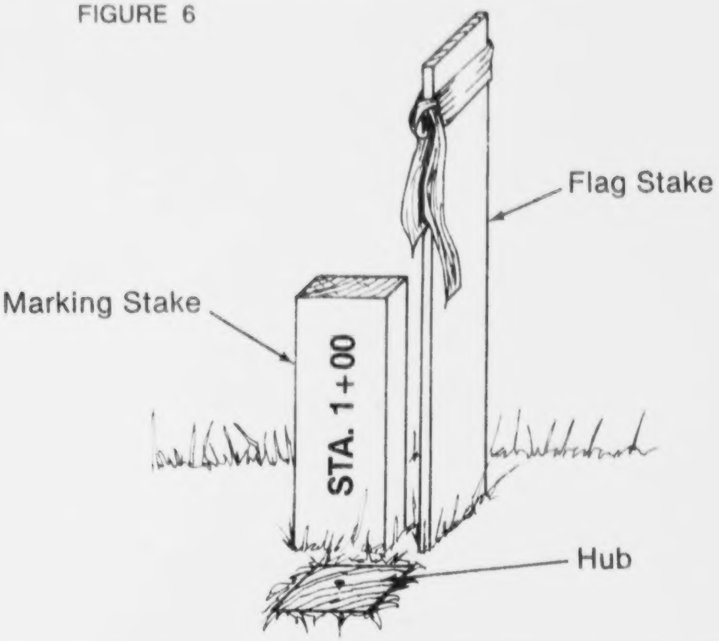
1. Flag stake — A thin long post with a flag which may be color-coded to mean center of road, edge of road, bottom of bank, etc.

2. Marking stake — Indicates station number.

   (NOTE: Information can also be given on the marking stake about cut and fill. For example, C-10 means to cut down 10 feet. F-4 means to fill four feet from top of hub.)

3. Hub — Indicates line, distance, or elevation.

FIGURE 6



F. Open traverses are usually numbered with stations from beginning point to end.

(NOTE: On a closed traverse the actual distance between changes in direction of lines are recorded in feet instead of station numbers.)

G. Stationing can be assigned to a survey in three ways:

1. Continuation of an adjoining survey

2. A station from an existing roadway

3. Beginning station may be assigned a number and new stationing established

   (NOTE: It is recommended that all surveys be assigned new stationing. Old stationing should be tied to the new alignment.)

INFORMATION SHEET

VII. Field notes

A. Are the only permanent record of work done in the field.

B. Data in field notes is normally used by drafters to make drawings or computations.

C. Reinhardt system of upper and lower case slope lettering is used as the lettering style to record notes. All upper case letters are reserved for emphasis.

D. Notes are lettered with a sharp, hard lead pencil such as 3-H or 4-11 so an indentation is made in the paper.

E. Erasing observed data is not permitted; incorrect entries are crossed out with a single line and the correct entry written in above.

(NOTE: Erasures can invalidate a field book.)

F. If an entire page is to be deleted, diagonal lines are drawn through the page and "VOID" is lettered prominently with the reasons.

G. Field notes are recorded at the time of the survey by a member of the survey crew, usually the party chief.

H. Field notes consist of numerical data, explanatory statements, and sketches.

I. Sketches in field notes are drawn proportionally and with a straight edge using standard mapping symbols. North is at the top or left side.

J. The word "COPY" should be lettered diagonally across pages that are non-original notes.

K. Field notes should be carefully stored as they often are the ultimate authority on a survey.

L. Red ink is used for information added to the field notes later back in the office.

M. Each day's work starts on a clean page.

(NOTE: Field notes are a living document. They should always be referred to for new surveys as they are considered the only legal starting point for a new survey.)

INFORMATION SHEET

VIII. Arrangement of field notes in the field book

A. Field notes should be organized in a form appropriate to the type of survey. Generally, standard forms are used for each of the different types of surveys. (Transparency 5)

B. Each book should be identified and indexed before recording notes. (Transparency 6)

   1. The note book owner's name and address appear on the cover and first inside page in permanent ink.

   2. All field books are numbered for record purposes.

C. All data pertaining to one survey or project should be entered in the same field book or series of field books.

D. Left and right hand pages are almost always used in pairs.

E. The upper left page or right page must include the following:

   1. Project name, location, date, time (a.m. or p.m.), and starting and finishing times.

   2. Weather — Important for applying corrections to tape lengths and other purposes.

   3. Names and initials of the survey party and their jobs described by symbols.

      a. Instrument operator ⊼

      b. Rod person Ø

      c. Notekeeper (or recorder) ≠ ◫ N 🕮

      d. Head tape person HT

   4. Instrument type and number

      (NOTE: The adjustment of the instrument may affect the accuracy of the survey.)

F. Each field book must have a table of contents.

G. Pages are numbered in the upper right hand corner of each right-hand page. A single page number is used for both the right and left-hand sides.

H. Notes are run down the page, except in route surveys where they are run up the page to conform with sketches.

INFORMATION SHEET

I. Descriptions and drawings should line up with corresponding numerical data.

Example: A bench mark description should line up with its elevation.

J. The left page of notes is generally ruled in six columns designed for tabulation only. (Transparency 5)

K. Column headings on the left page are placed between the first two horizontal lines at the page top and follow from left to right in order of reading and recording.

IX. Methods of recording field notes

A. Bound books

1. Standard for many years
2. Have a sewn binding, hard cover, and 80 leaves
3. Ensure maximum testimony acceptability for property survey records in courtrooms.
4. Bound duplicating books have a duplicate sheet that becomes a copy and can be removed.

B. Loose-leaf books

1. Advantages
    a. Have a flat-working surface
    b. Make it simpler to file individual project notes
    c. Allow ready transfer of partial sets of notes between field and office.
    d. Make it possible to use different rulings in the same book.
    e. Save sheets

    (NOTE: None are wasted, and you use only what you need.)
2. Disadvantages
    a. Make it possible to lose individual sheets, which presents legal implications because data can be added or deleted.
    b. There is the potential for cheaper quality paper.

INFORMATION SHEET

C. Electronic data recorders

1. Electronic theodolite, distance measuring units, and total station systems provide visually displayed digital readings.
2. Often field sketches and other handwritten information must still be recorded by hand because data may be accidentally erased by a magnetic field or faulty battery.

D. Camera

1. A helpful notekeeping instrument.
2. Can produce visual photographic records of monuments and other admissable field evidence.

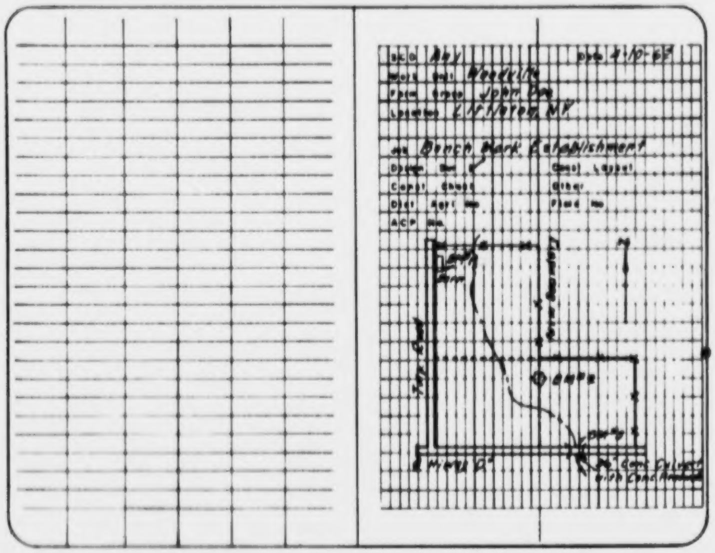
   (NOTE: Rubbings can also be made of the tops of survey monuments to record their elevation data.)

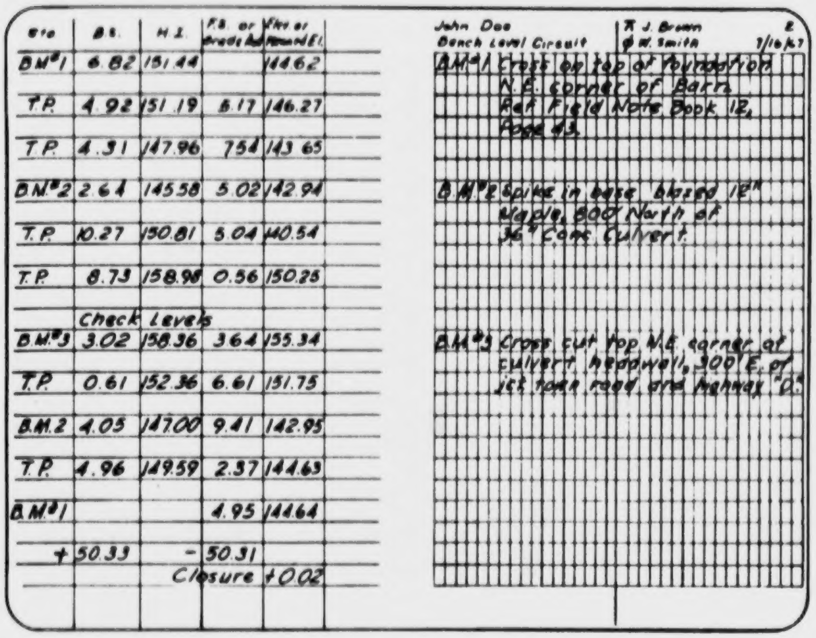
INFORMATION SHEET

X. Examples of types of field notes

A. Bench level circuit (Figure 7)

FIGURE 7





Sta	B.S.	H.I.	F.S. or Grade Rod	Elev. or Ground El.
BM#1	6.82	151.44		144.62
T.P.	4.92	151.19	6.17	146.27
T.P.	4.31	147.96	7.54	143.65
B.M.#2	2.64	145.58	5.02	142.94
T.P.	10.27	150.81	5.04	140.54
T.P.	8.73	158.98	0.56	150.25
	Check Levels			
B.M.#3	3.02	158.36	3.64	155.34
T.P.	0.61	152.36	6.61	151.75
B.M.2	4.05	147.00	9.41	142.95
T.P.	4.96	149.59	2.37	144.63
B.M.#1			4.95	144.64
+	50.33	-	50.31	
		Closure		+0.02

John Doe | ⊼ J. Brown | 2
Bench Level Circuit | ϕ W. Smith | 7/10/57

B.M.#1 Cross on top of foundation N.E. corner of Barn. Ref Field Note Book 12, Page 43.

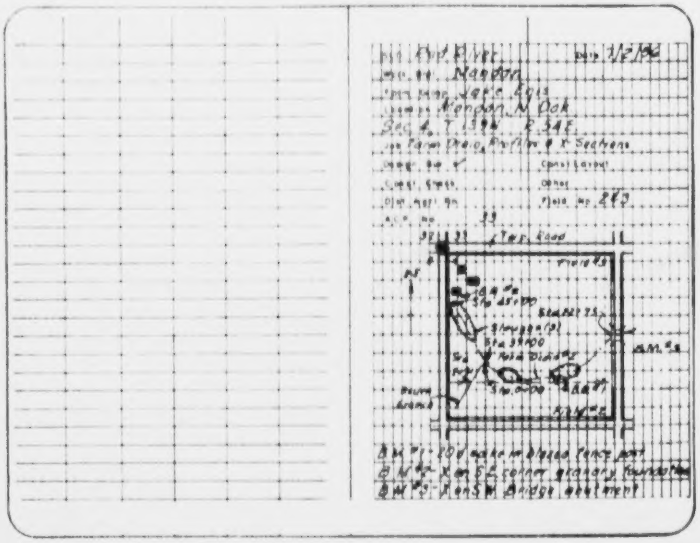
B.M.#2 Spike in base blazed 18" Maple, 800' North of 36" Conc. Culvert.

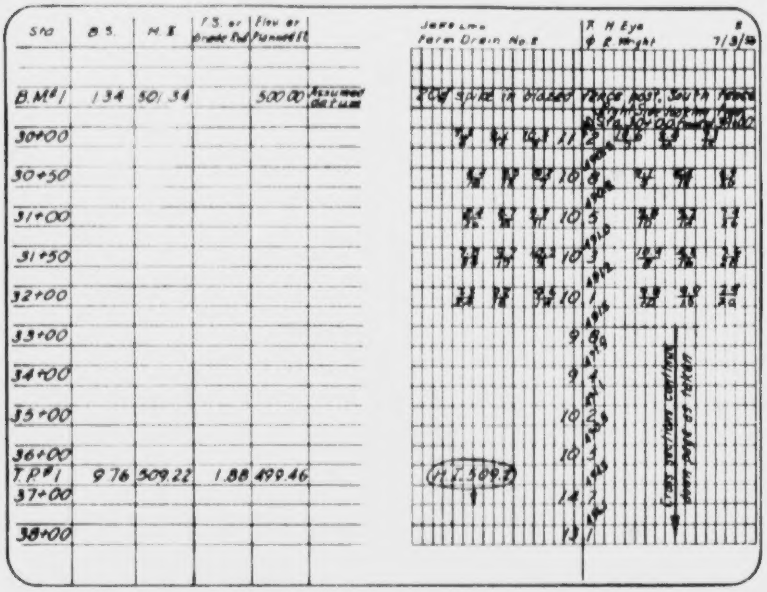
B.M.#3 Cross cut top N.E. corner of culvert headwall, 300' E. of jct town road and highway "D."

INFORMATION SHEET

B. Profile and cross sections (Figures 8 and 9)

FIGURE 8





Sta	B.S.	H.I.	F.S. or Grade Rod	Elev or Planned El.	
B.M.#1	1 34	501 34		500 00	Assumed datum
30+00					
30+50					
31+00					
31+50					
32+00					
33+00					
34+00					
35+00					
36+00					
T.P.#1	9 76	509.22	1.88	499.46	
37+00					
38+00					

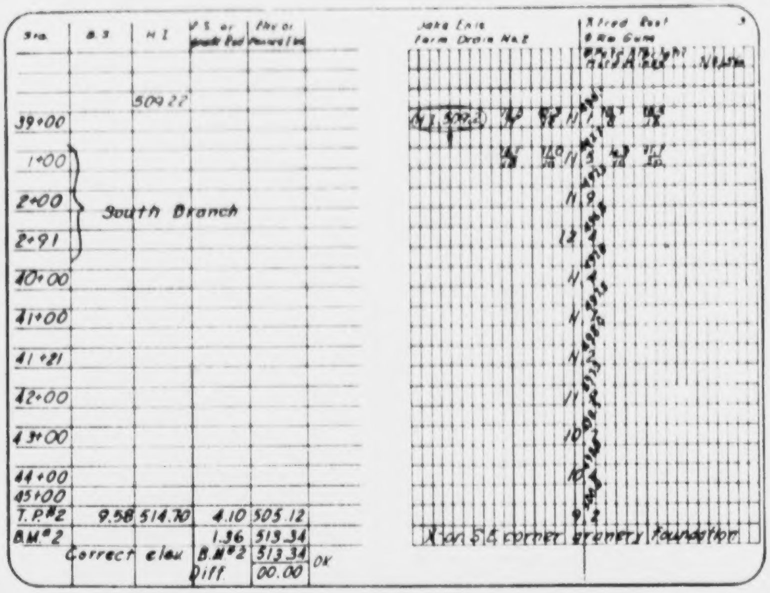
Farm Drain No 2

20d spike in blazed fence post. South fence

H.I. 509.2

INFORMATION SHEET

FIGURE 9



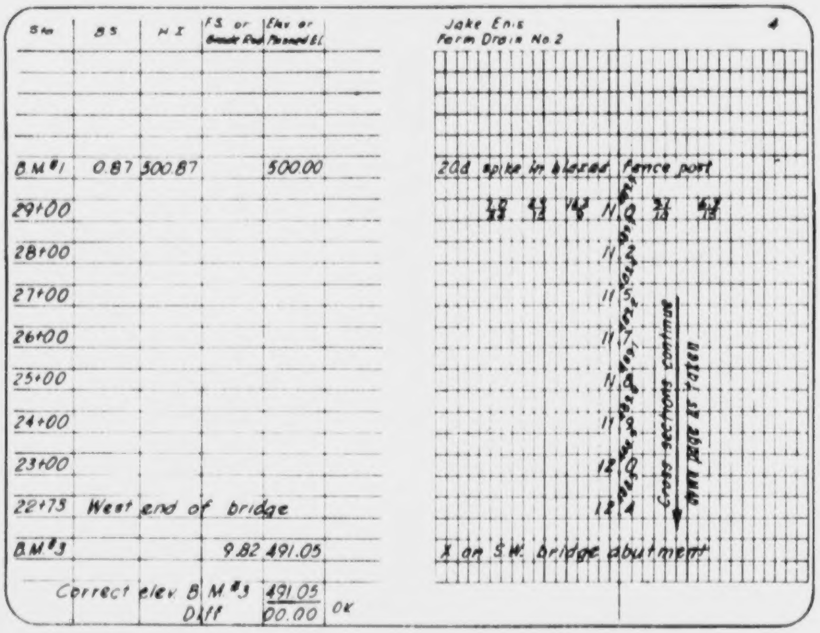
Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev or Passed El.
		509.22		
39+00				
1+00	South Branch			
2+00				
2+91				
40+00				
41+00				
41+21				
42+00				
43+00				
44+00				
45+00				
T.P.#2	9.58	514.70	4.10	505.12
B.M.#2			1.36	513.34
	Correct elev		B.M.#2	513.34 OK
			Diff.	00.00

Jake Enis
Farm Drain No 2

X Fred Post
0 Rw Gum

3

X on S.E. corner granery foundation



Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev or Passed El.
B.M.#1	0.87	500.87		500.00
29+00				
28+00				
27+00				
26+00				
25+00				
24+00				
23+00				
22+75	West end of bridge			
B.M.#3			9.82	491.05
	Correct elev. B.M.#3			491.05 OK
			Diff	00.00

Jake Enis
Farm Drain No 2

4

20d spike in blazed fence post

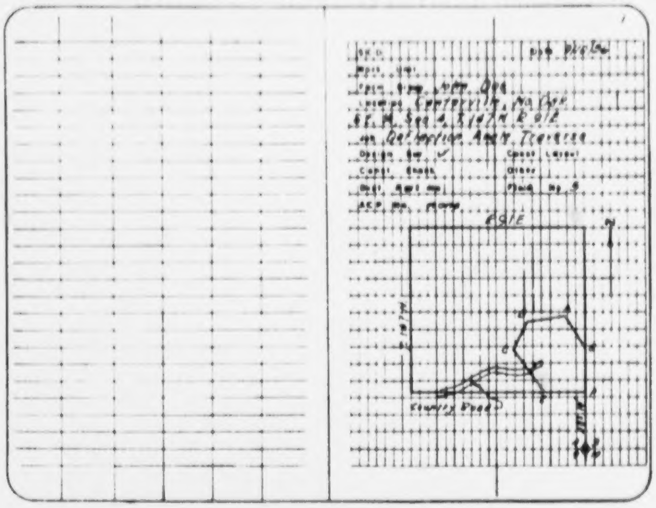
Cross sections continue

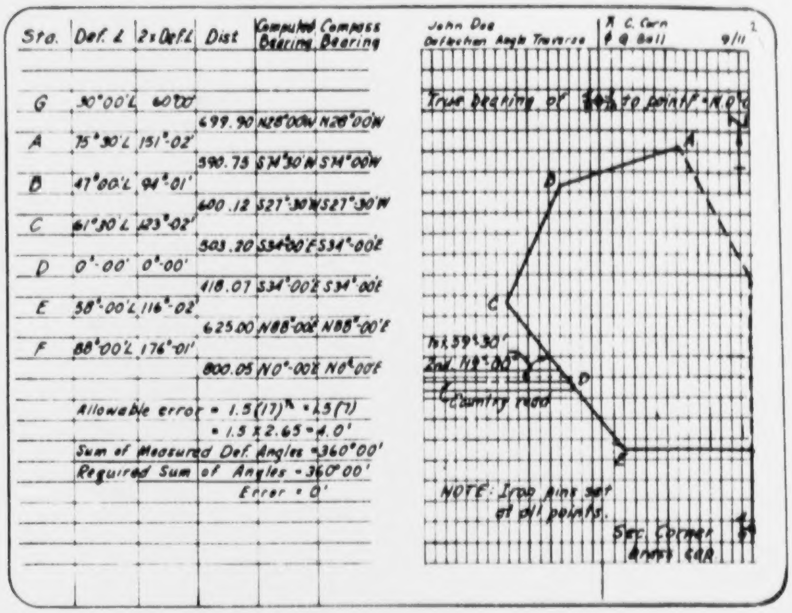
X on S.W. bridge abutment

INFORMATION SHEET

C. Deflection angle traverse (Figure 10)

FIGURE 10


1
Deflection Angle Traverse
Country Road
N



Sta.	Def. ∠	2x Def. ∠	Dist	Computed Bearing	Compass Bearing
G	30°00'L	60°00'			
			699.90	N28°00'W	N28°00'W
A	75°30'L	151°-02'			
			390.75	S74°30'W	S74°00'W
B	47°00'L	94°-01'			
			600.12	S27°-30'W	S27°-30'W
C	61°30'L	123°-02'			
			503.20	S34°00'E	S34°-00'E
D	0°-00'	0°-00'			
			418.07	S34°00'E	S34°00'E
E	58°-00'L	116°-02'			
			625.00	N88°00'E	N88°-00'E
F	88°00'L	176°-01'			
			800.05	N0°-00'E	N0°00'E

Allowable error = 1.5(17)^½ = 1.5(7)
= 1.5 x 2.65 = 4.0'

Sum of Measured Def. Angles = 360°00'

Required Sum of Angles = 360°00'

Error = 0'

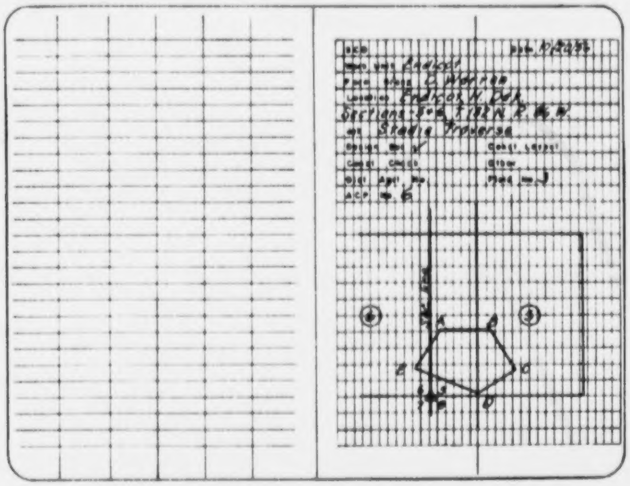
John Doe
Deflection Angle Traverse
⊼ C. Corn
ϕ Q Ball
9/11
2

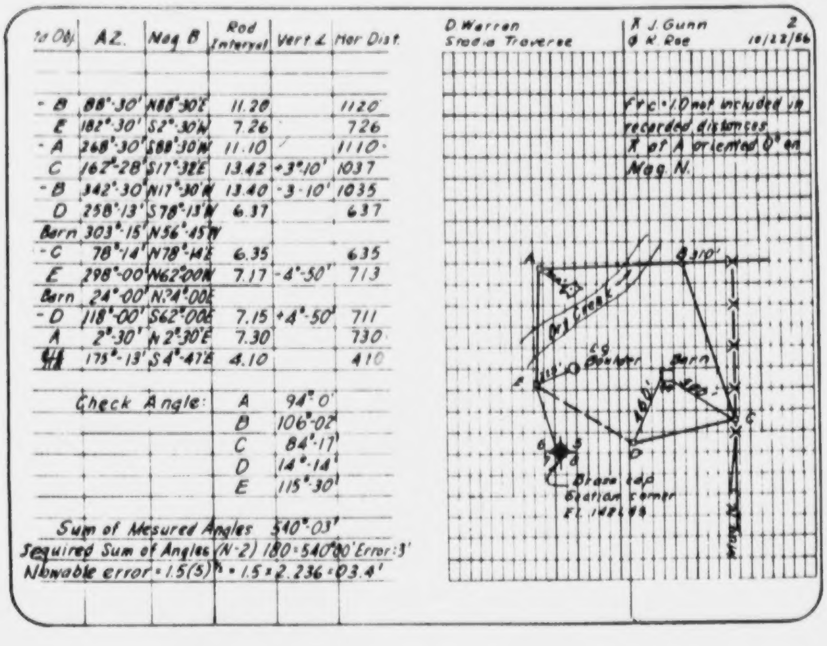
True bearing of Sec. to point F = N 0°E
A
B
C
D
E
F
1st. 59°30'
2nd. 119°00'
Country road
NOTE: Iron pins set at all points.
Sec. Corner
Brass Cap

INFORMATION SHEET

D. Stadia traverse (Figure 11)

FIGURE 11





To Obj.	AZ.	Mag B	Rod Interval	Vert ∠	Hor Dist.
- B	88°-30'	N88°30'E	11.20		1120
E	182°-30'	S2°-30'W	7.26		726
- A	268°-30'	S88°30'W	11.10		1110
C	162°-28'	S17°-32'E	13.42	+3°-10'	1037
- B	342°-30'	N17°-30'W	13.40	-3-10'	1035
D	258°-13'	S78°-13'W	6.37		637
Barn	303°-15'	N56°-45'W			
- C	78°-14'	N78°-14'E	6.35		635
E	298°-00'	N62°00'W	7.17	-4°-50'	713
Barn	24°-00'	N.24°-00E			
- D	118°-00'	S62°-00E	7.15	+4°-50'	711
A	2°-30'	N 2°-30'E	7.30		730
[illegible]	175°-13'	S 4°-47'E	4.10		410

Check Angle:

A	94° 0'
B	106°-02'
C	84°-17'
D	14°-14'
E	115°-30'

Sum of Mesured Angles 540°-03'

Required Sum of Angles (N-2) 180 = 540°00' Error: 3'

Allowable error = 1.5(5)½ = 1.5 × 2.236 = 03.4'

D Warren
Stadia Traverse

⊼ J. Gunn
Φ K. Roe

2
10/22/86

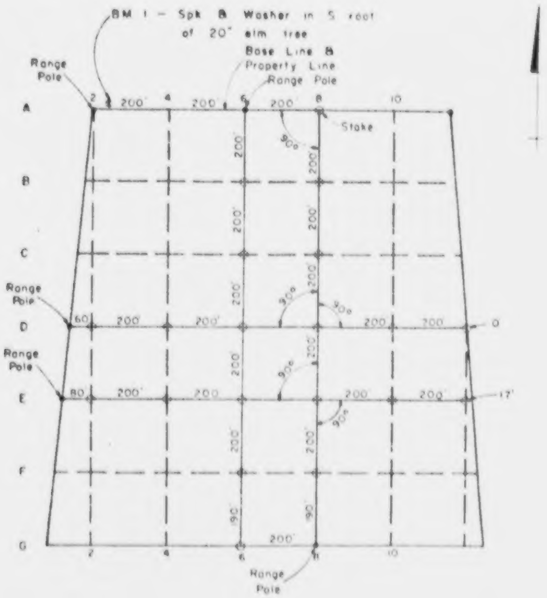
F+c = 1.0 not included in recorded distances
⊼ at A oriented 0° on Mag. N.

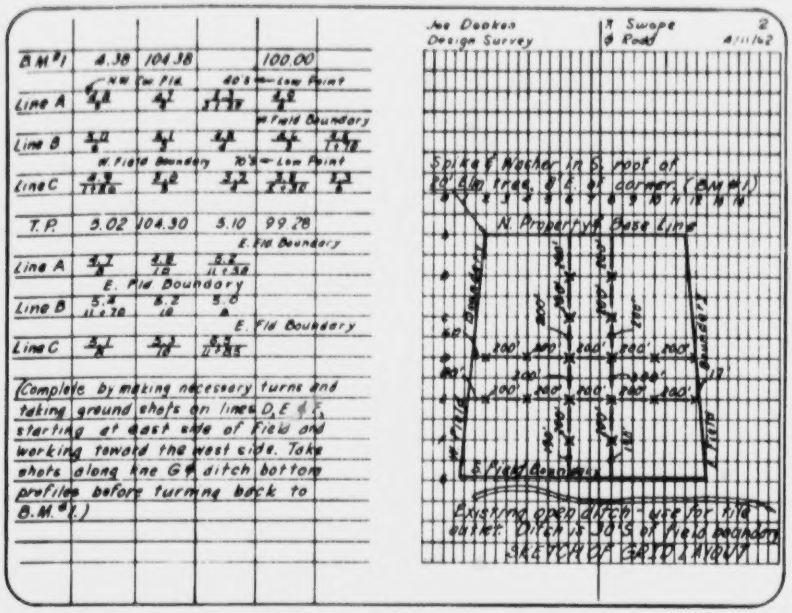
A
B
C
D
E
Dry Creek
Log Booster
Barn
Brass cap
Section corner
El. 1482.98
6
5
7
8

INFORMATION SHEET

E. Grid survey (Figure 12)

FIGURE 12


BM 1 – Spk & Washer in S root of 20" elm tree
Base Line & Property Line Range Pole
Range Pole
Stake
A
B
C
D
E
F
G
2
4
6
8
10
200'
90°
60
80
0
17'
190'
Range Pole



B.M.#1	4.38	104.38		100.00	
	NW Cor Fld		40's ← Low Point		
Line A	4.8/2	4.7/4	5.3/5+40	4.9/8	
				← Field Boundary	
Line B	5.0/2	5.1/4	4.8/6	4.5/8	5.6/11+18
	W. Field Boundary		70's ← Low Point		
Line C	4.9/1+80	5.0/3	5.2/4	5.1/5+30	5.3/6
T.P.	5.02	104.30	5.10	99.28	
			E. Fld Boundary		
Line A	5.7/8	4.8/10	5.2/11+30		
	E. Fld Boundary				
Line B	5.4/11+70	5.2/10	5.0/8		
			E. Fld Boundary		
Line C	5.1/8	5.3/10	5.5/11+85		

(Complete by making necessary turns and taking ground shots on lines D, E & F, starting at east side of Field and working toward the west side. Take shots along line G & ditch bottom profiles before turning back to B.M.#1.)

Joe Doakes
Design Survey

X Swope
⊕ Rod

2
4/11/62

Spike & Washer in S. root of 20" Elm tree, N.E. of corner. (BM #1)

N. Property & Base Line

W. Field Boundary

E. Field Boundary

S. Field Boundary

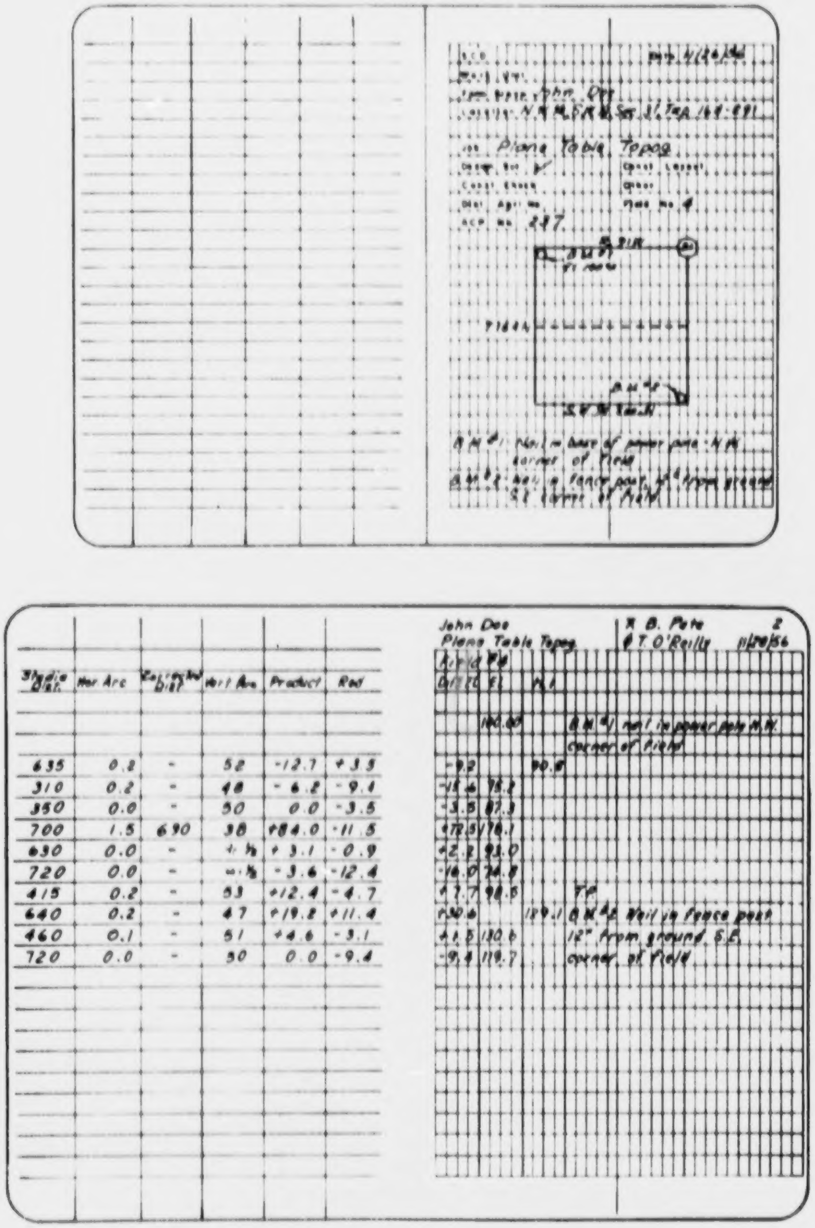
Existing open ditch - use for tile outlet. Ditch is 30' S of field boundary

SKETCH OF GRID LAYOUT

INFORMATION SHEET

F. Planetable topography (Figure 13)

FIGURE 13



Plane Table Topog

287

B.M. #1: Nail in base of power pole: N.W. corner of field

B.M. #2: Nail in fence post 12" from ground S.E. corner of field

Stadia Dist.	Hor Arc	Corrected Dist.	Vert Arc	Product	Rod
635	0.2	-	52	-12.7	+3.3
310	0.2	-	48	-6.2	-9.1
350	0.0	-	50	0.0	-3.5
700	1.5	690	38	+84.0	-11.5
630	0.0	-	+½	+3.1	-0.9
720	0.0	-	-½	-3.6	-12.4
415	0.2	-	53	+12.4	-4.7
640	0.2	-	47	+19.2	+11.4
460	0.1	-	51	+4.6	-3.1
720	0.0	-	50	0.0	-9.4

John Doe
Plane Table Topog.

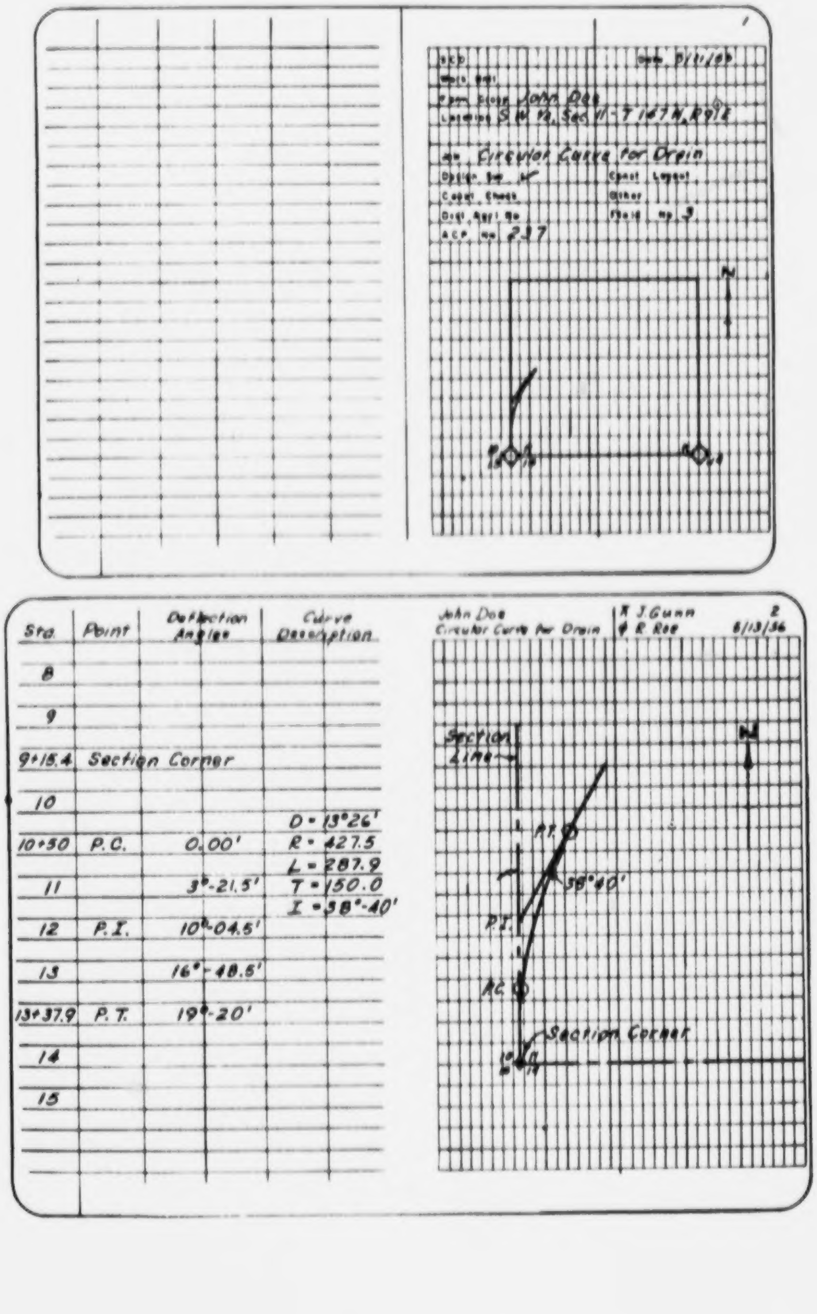
B. Pete 2
T. O'Reilly 11/20/56

100.00 B.M. #1 nail in power pole N.W. corner of field
-9.2 90.8
-15.6 75.2
-3.5 87.3
+12.5 70.1
+2.2 93.0
-16.0 74.8
+7.7 98.5 T.P.
+30.6 129.1 B.M. #2 Nail in fence post
+1.5 130.6 12" from ground S.E.
-9.4 119.7 corner of field

INFORMATION SHEET

G. Circular curves (Figure 14)

FIGURE 14



1

Date 8/11/56

Farm Oper. John Doe

Location S W ¼, Sec 11 - T 147 N, R 91 E

Job Circular Curve for Drain

Design Sur. ✓

Const. Layout

Const. Check

Other

Dist. Agr. No.

Field Bk No. 3

ACP No. 237

Sta.	Point	Deflection Angle	Curve Description
8			
9			
9+15.4	Section Corner		
10			
			D = 13°26'
10+50	P.C.	0.00'	R = 427.5
			L = 287.9
11		3°-21.5'	T = 150.0
			I = 38°-40'
12	P.I.	10°-04.5'	
13		16°-48.5'	
13+37.9	P.T.	19°-20'	
14			
15			

John Doe
Circular Curve for Drain

⊼ J. Gunn
ϕ R. Roe

2
8/13/56

INFORMATION SHEET

XI. **Traverses (Transparency 7)**

A. Consist of a series of lines known as courses.

B. The points where the courses intersect are known as traverse stations.

C. The length of the courses are referred to as horizontal distances and given as horizontal angles.

D. Horizontal directions are given in terms of azimuth or bearings.

E. Traverses come in two different types.

1. Open traverse

2. Closed traverse

a. Loop traverse — Closes on itself

b. Connecting traverse — Starts and ends at known locations

XII. **Direction of a line/course by bearings or azimuths** (Transparency 8)

A. Bearing direction

1. Is an acute horizontal angle which a line makes with the meridian of reference.

2. Is measured from the north or south end of a meridian.

3. To determine which side of the meridian the bearing goes, an east or west is added.

Example: S 65°07′34″ W
N 35°15′ E

4. Is measured clockwise or counterclockwise.

5. Range from 0 to 90 degrees; can **never** be greater than 90°.

6. Is expressed in degrees, minutes, and seconds.

7. Usually established from either a line in which the bearing is known or an astronomical observation.

8. There are four types of bearings.

a. True bearing — Measures from the true north-south meridian.

b. Magnetic bearing — Measures from the magnetic north-south meridian.

INFORMATION SHEET

c. Assumed bearing — Measures from an arbitrary north-south meridian.

d. Grid bearing — Measures from a central north-south meridian.

B. Azimuth direction

1. Is the direction a line is deflected from either the north or south meridian.

2. Is measured clockwise only.

3. Range from 0 to 360°.

4. Is measured in degrees, minutes, and seconds.

5. Requires only a numerical value.

6. The reference meridian is usually north.

(NOTE: South meridian is sometimes used for geodetic surveys that cover large areas.)

7. The type of meridian system used defines the type of azimuth used.

8. There are four types of azimuths.

a. True azimuth — Measures from the true meridian.

b. Magnetic azimuth — Measures from the magnetic meridian.

c. Assumed azimuth — Measures from an arbitrary meridian line.

d. Grid azimuth — Measures from a central meridian in a grid system.

XIII. Conversion of azimuth to bearings and bearings to azimuths

A. Converting azimuth to a bearing angle

1. An azimuth from north (Az N) between 0° and 90° is in the northeast quadrant. The bearing angle is the same as the azimuth.

Az N = Bearing

2. An azimuth from north between 90° and 180° is in the southeast quadrant. The bearing angle is calculated by subtracting the azimuth from 180°.

180° - Az N = Bearing

INFORMATION SHEET

3. An azimuth from north between 180° and 270° lies in the southwest quadrant. The bearing angle is calculated by subtracting 180° from the azimuth.

   Az N - 180° = Bearing

4. An azimuth from north between 270° and 360° is in the northwest quadrant. The bearing angle is calculated by subtracting the azimuth from 360°.

   360° - Az N = Bearing

5. An azimuth from north at 0° or 360° has a bearing of due north; an azimuth of 90° has a bearing of due east. An azimuth of 180° has a bearing of due south, and an azimuth of 270° has a bearing of due west.

B. Converting bearing to azimuth

1. The azimuth of a line in the northeast quadrant is the same as the bearing angle.

   Azimuth = Bearing

2. The azimuth of a line in the southeast quadrant is 180° minus the bearing angle.

   180° - Bearing = Azimuth

3. The azimuth of a line in the southwest quadrant is 180° plus the bearing angle.

   180° + Bearing = Azimuth

4. The azimuth of a line in the northwest quadrant is 360° minus the bearing angle.

   360° – Bearing = Azimuth

XIV. **Methods for plotting traverses** (Transparencies 9 — 11)

A. Interior angles — Three sets of data must be known.

1. Location of starting point and its relationship to at least one other traverse course.

2. The distances of the traverse courses.

3. The interior angle for each traverse station.

INFORMATION SHEET

B. Distance and bearing

  1. Is the easiest method.

  2. Plotting is based on the principle of locating traverse stations relative to their bearing to other stations.

  3. Bearings are presented in two formats.

    a. Bearing

    b. Back bearing

  4. To plot a traverse by distance and bearing, the distance and bearing/back bearing of each station must be known.

C. Azimuth

  1. Azimuth traverses present a series of lines that are related to one another by angle measurement only.

  2. Two sets of data are required.

    a. Direction and distance of two known stations from which all azimuth readings are taken.

    b. Azimuth readings for all traverse points from the two known stations.

D. Deflection angles

  1. Used to indicate the direction and order of each succeeding traverse course.

  2. Angular measurements are made in a clockwise direction toward the forward direction.

  3. Deflection angle is the angle between the back course and the forward course.

  4. Deflection angle indicates the direction change of each traverse course relative to individual traverse stations.

  5. This method is common in laying out route surveys and utility system construction.

  6. Advantages for using deflection angles include

    a. Azimuths can easily be calculated.

    b. Are used to calculate circular curves in transportation systems.

    c. Can be plotted easily.

INFORMATION SHEET

7. When laying out a traverse by deflection angle, the first course is usually located by bearing or azimuth.

E. Angle to the right

1. Is a clockwise angle between the preceding line and the next line of a traverse.

2. It is assumed the survey proceeds from Point A to Point B, then to C and on. The angle to the right is obtained by sighting back to B and measuring the clockwise angle to D.

F. Latitudes and departures

1. Is a common method used in plotting closed traverses.

2. Latitude of a course is the distance that it extends in a north or south direction.

3. Courses that run in a northerly direction have a plus (+) latitude and those in a southerly direction have a minus (-) latitude.

4. Departure of a course is the distance that it extends in the east or west direction.

5. Courses running easterly are (+) plus departures and (-) minus departures run westerly.

6. Calculations to find latitude and departure of a bearing:

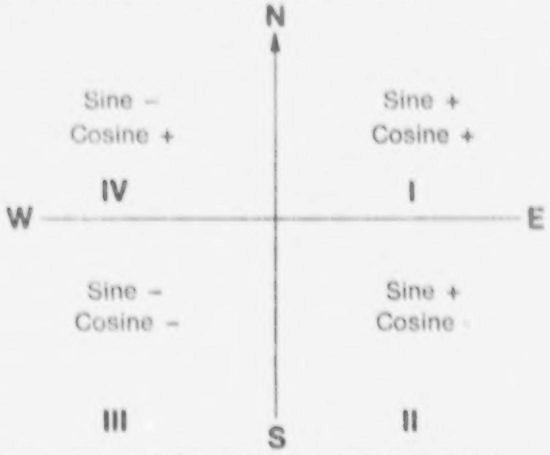
   Latitude = D cos B
   Departure = D sin B
   (D = Distances of course)
   (B = Bearing angle)

7. Calculations to find latitude and departure of an azimuth (north):

   Latitude = D cos A
   Departure = D sin A
   (D = Distance of course)
   (A = Azimuth N)

INFORMATION SHEET

8. Using the sine quadrants, the latitudes and departures can be determined by observing where the bearing falls.



Example: A bearing S 45° E lies in Quad. II.
The latitude would be (-) minus.
The departure would be (+) plus.

9. Traverses can be plotted by latitudes and departures using a plotting table. The plotting table consists of basic surveying data plus latitudes and departures.

G. Rectangular coordinates

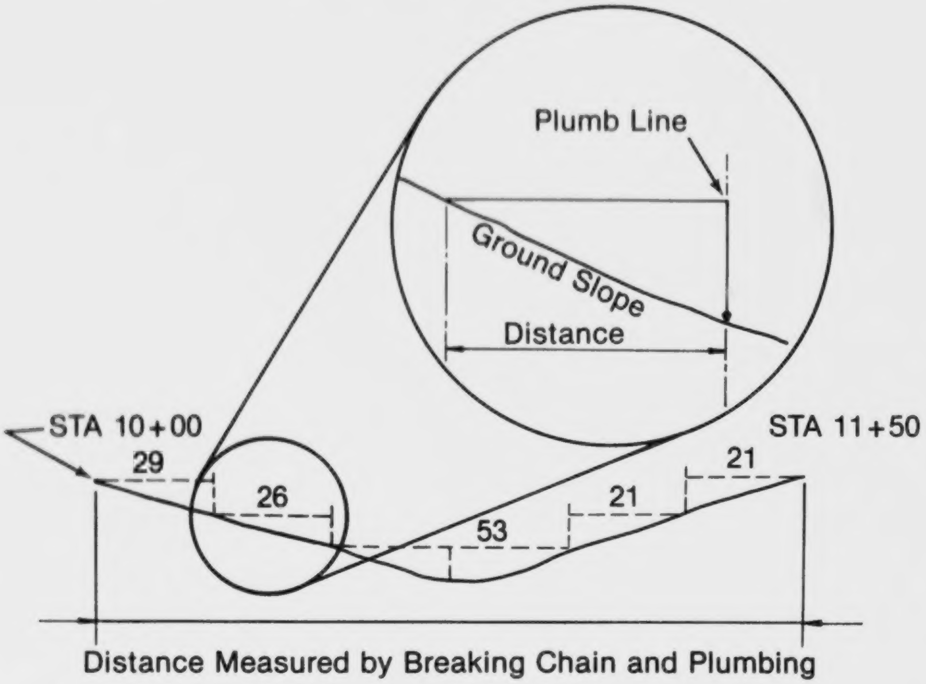
1. Are the most accurate way to plot traverses.
2. Advantages in using rectangular coordinates:
   a. Error in plotting doesn't affect the plotting of succeeding stations.
   b. Accuracy of a station location can be checked by measuring its distance to the preceding station.
   c. Size of final map can be determined by examining the coordinates.
3. The coordinates are based on an X and Y line that are perpendicular to each other.
4. The X and Y line can be drawn arbitrarily or drawn to correspond to the meridian.
5. If the coordinates are drawn to a meridian, then latitudes and departures are used to plot each point.

INFORMATION SHEET

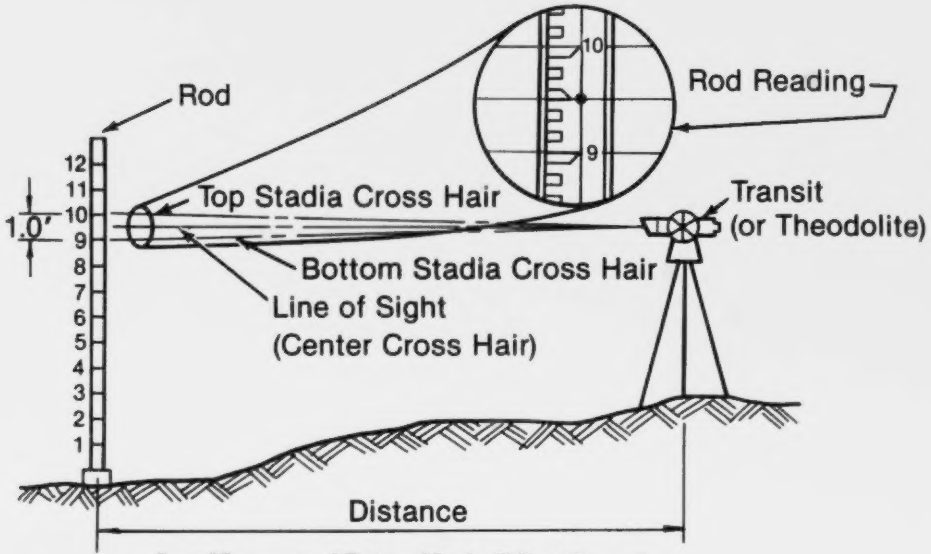
6. Steps to plot with an arbitrary grid:
    - a. Grid lines are drawn (X, Y lines perpendicular to each other)
    - b. The lines are spaced at a constant interval

      Examples: 10, 50, 100, or 500 feet
    - c. Spacing of the intervals depends on the scale of the drawing.
    - d. Each line is labeled with its designated value.
    - e. Each point (station) on a traverse is plotted according to its distance from the nearest grid line.
    - f. Accuracy of a station location can be checked by measuring the distance to a preceding station.
7. North is considered positive, south is considered negative.
8. East is considered positive, west is considered negative.

Measuring Horizontal Distances

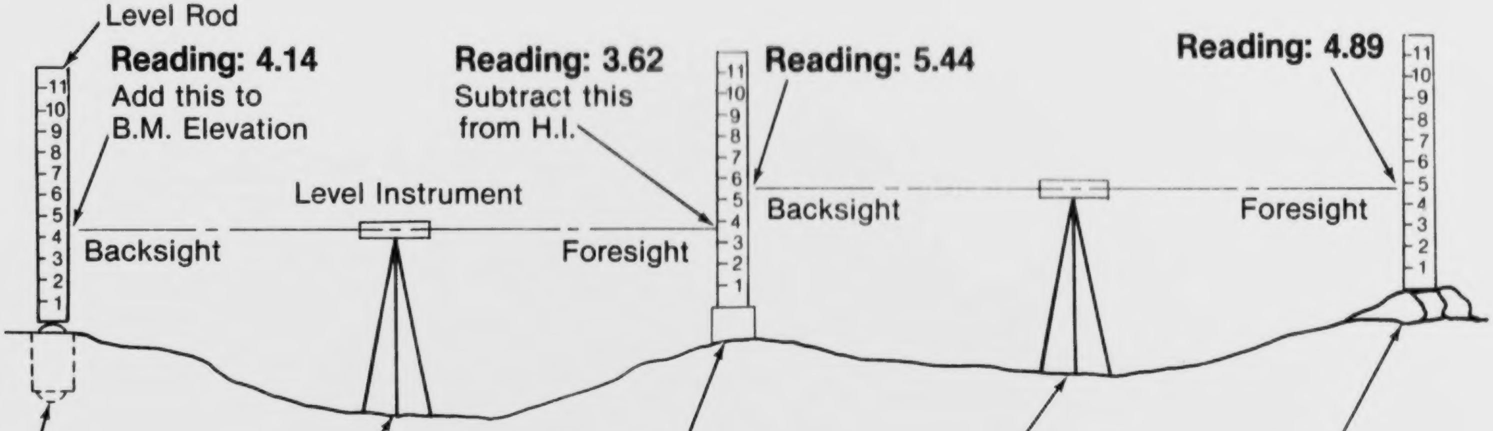

Plumb Line
Ground Slope
Distance
STA 10+00
STA 11+50
29
26
53
21
21
Distance Measured by Breaking Chain and Plumbing

Direct Method — Taping


Rod
Rod Reading
10
9
12
11
10
9
8
7
6
5
4
3
2
1
1.0'
Top Stadia Cross Hair
Bottom Stadia Cross Hair
Line of Sight
(Center Cross Hair)
Transit
(or Theodolite)
Distance

Indirect (Stadia) Method

Finding an Elevation With a Level and a Rod



Level Rod
Level Instrument
Backsight
Foresight
Backsight
Foresight

Reading: 4.14
Add this to
B.M. Elevation

Reading: 3.62
Subtract this
from H.I.

Reading: 5.44

Reading: 4.89

Elevation
1000.00′
USGS BM
Beginning Point

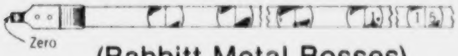
H.I. = 1000.00′
+ 4.14
1004.14′

TP1 = 1004.14′
– 3.62
1000.52′

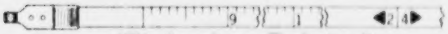
H.I. = 1000.52′
+ 5.44
1005.96′

TP2 = 1005.96′
– 4.89
1001.07′

Surveying Equipment

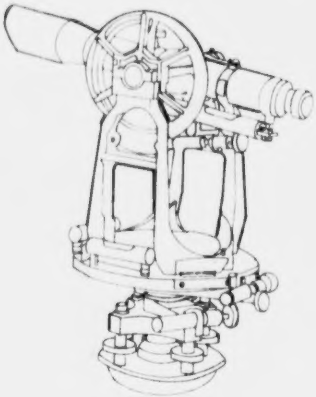


(Babbitt Metal Bosses)

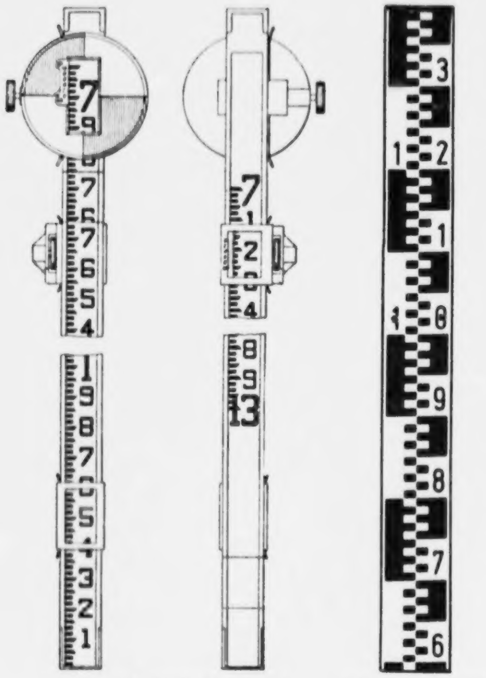


(Etched or Painted)

Tapes (Steel)



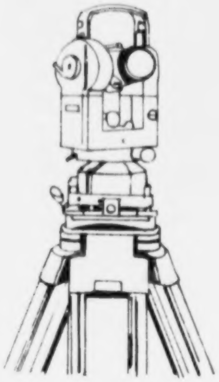
Transit



Philadelphia Rod
(Front) (Back)

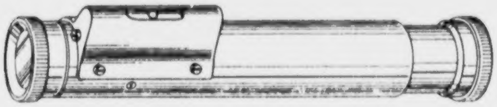
Metric Rod

Level Rods

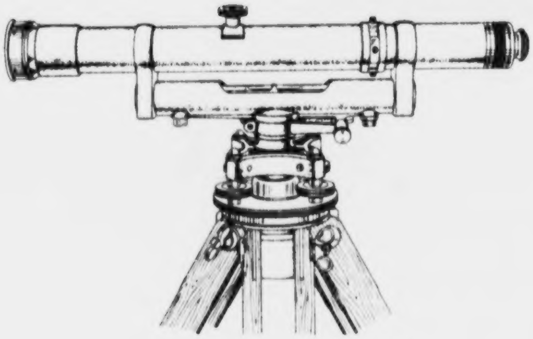


Theodolite

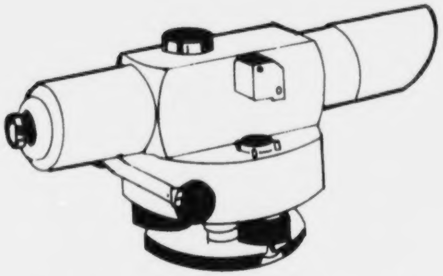
Surveying Equipment
(Continued)



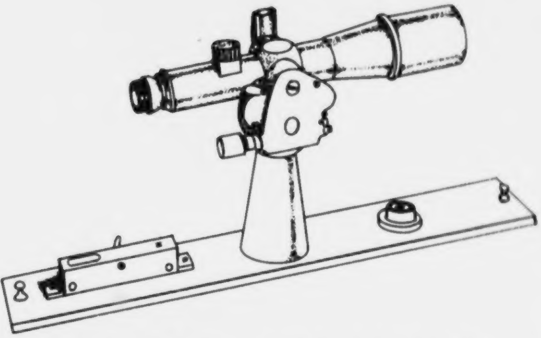
Hand Level



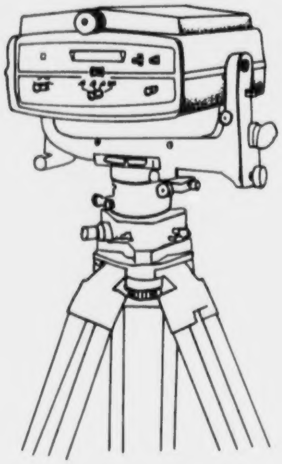
Dumpy Level



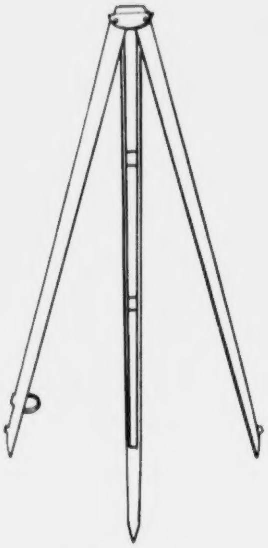
Self-Leveling Level



Planetable and Alidade

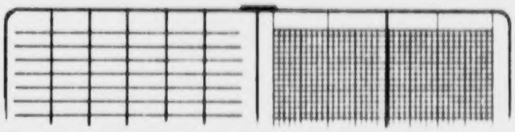


EDM

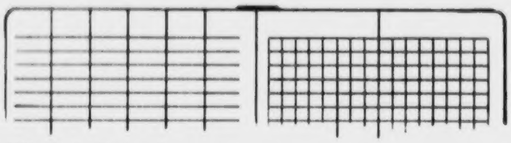


Tripod

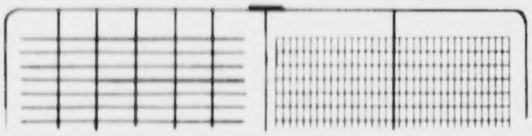
Styles of Field Note Paper



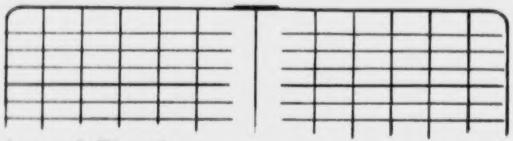
Engineer's Field Book
Left page: Blue horizontal lines; red vertical lines. Right page: 10 × 10 blue lines; red vertical center line. Inch lines heavy.



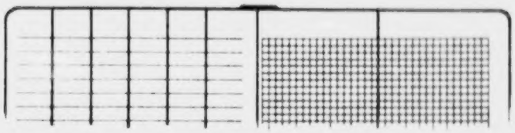
Field Book
Left page: Blue horizontal lines; red vertical lines. Right page: 4 × 4 blue line; red vertical center line.



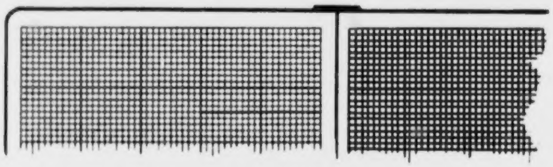
Transit Field Book
Left page: Blue horizontal lines; red vertical lines. Right page: 8 vertical lines and 4 horizontal blue lines; red vertical center line.



Level Book
Both pages: Blue horizontal lines; red vertical lines. 6 vertical columns.

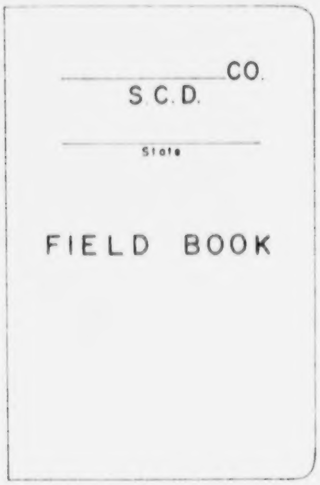


Mining Transit Book
Left page: Blue horizontal lines; red vertical lines. Right page: 8 × 8 blue lines; red vertical center line.



Cross Section Book
Both pages: 10 × 10 blue lines; inch lines slightly heavier.

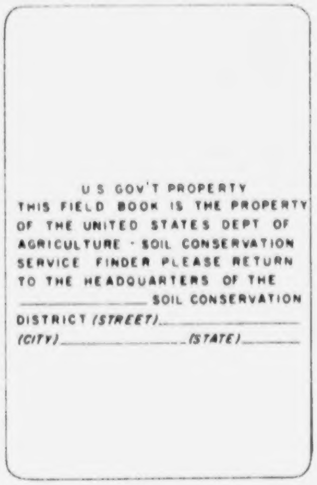
Initializing a Field Book



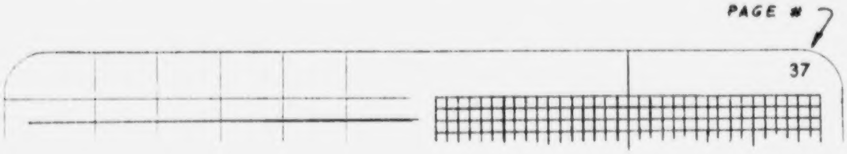
_______ CO.
S.C.D.

____
State

FIELD BOOK

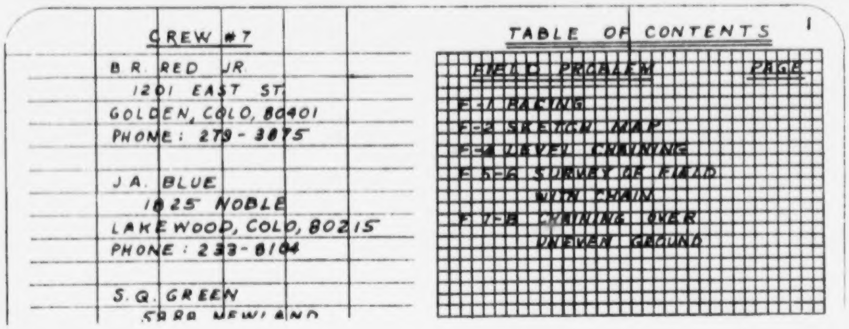


U S GOV'T PROPERTY
THIS FIELD BOOK IS THE PROPERTY OF THE UNITED STATES DEPT OF AGRICULTURE - SOIL CONSERVATION SERVICE FINDER PLEASE RETURN TO THE HEADQUARTERS OF THE _______ SOIL CONSERVATION DISTRICT *(STREET)* _______
(CITY) _______ *(STATE)* _______



PAGE #

37



CREW #7

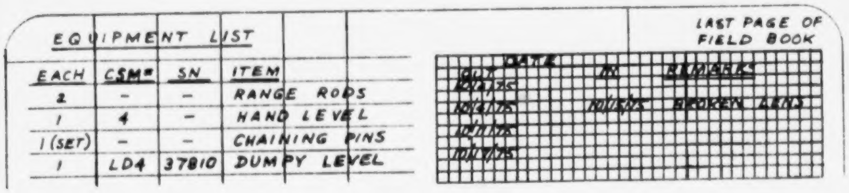
B.R. RED JR.
1201 EAST ST.
GOLDEN, COLO, 80401
PHONE: 279-3875

J.A. BLUE
1825 NOBLE
LAKEWOOD, COLO, 80215
PHONE: 233-8104

S.Q. GREEN
5888 NEWLAND

TABLE OF CONTENTS 1

FIELD PROBLEM	PAGE
F-1 PACING	
F-2 SKETCH MAP	
F-4 LEVEL CHAINING	
F 5-6 SURVEY OF FIELD WITH CHAIN	
F 7-8 CHAINING OVER UNEVEN GROUND	



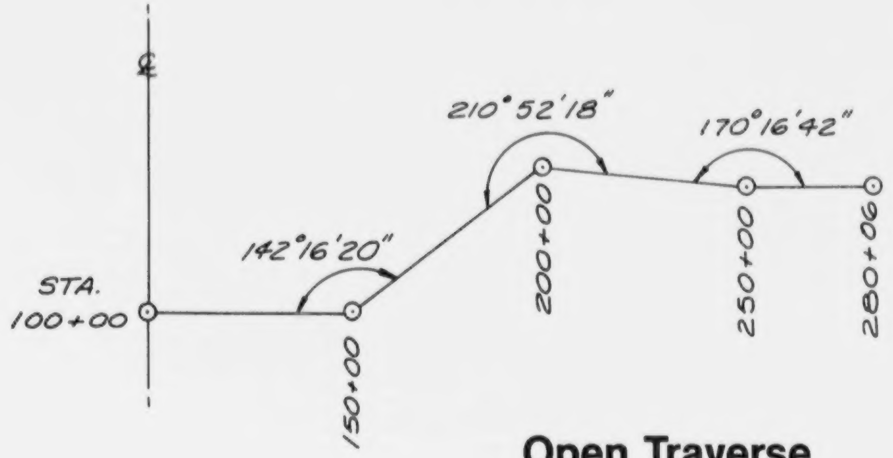
EQUIPMENT LIST

EACH	CSM#	SN	ITEM
2	–	–	RANGE RODS
1	4	–	HAND LEVEL
1 (SET)	–	–	CHAINING PINS
1	LD4	37810	DUMPY LEVEL

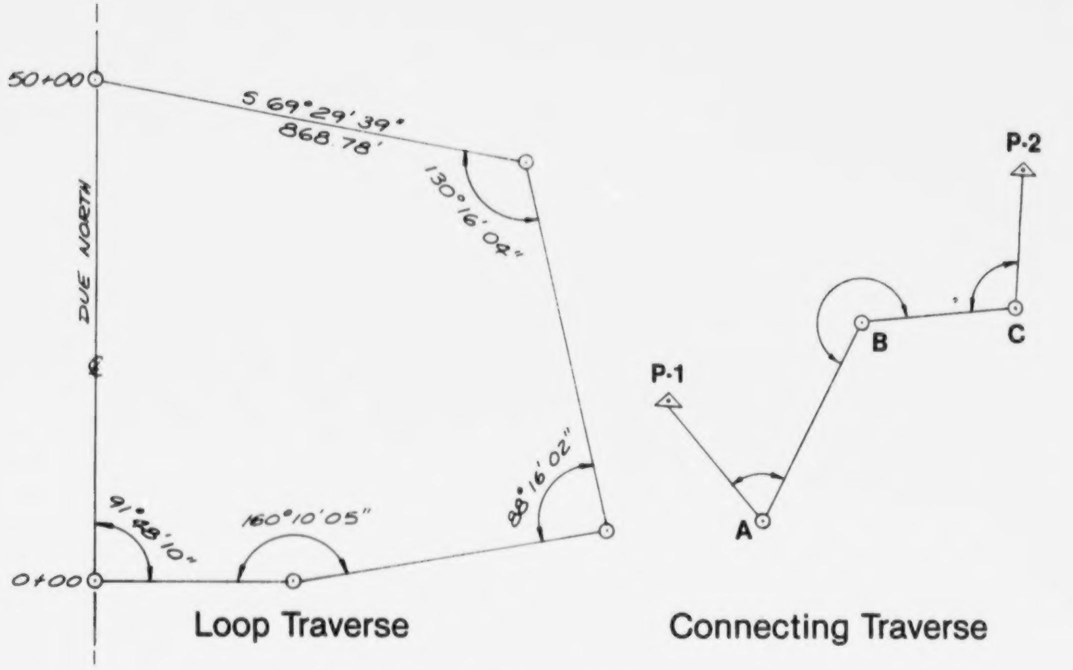
LAST PAGE OF FIELD BOOK

DATE OUT	IN	REMARKS
[illegible]		
[illegible]	[illegible]	BROKEN LENS
[illegible]		
[illegible]		

Types of Traverses


℄
210°52'18"
170°16'42"
142°16'20"
STA.
100+00
150+00
200+00
250+00
280+06

Open Traverse


50+00
S 69°29'39"
868.78'
130°16'04"
DUE NORTH
℄
88°16'02"
91°28'10"
160°10'05"
0+00
P-2
P-1
B
C
A

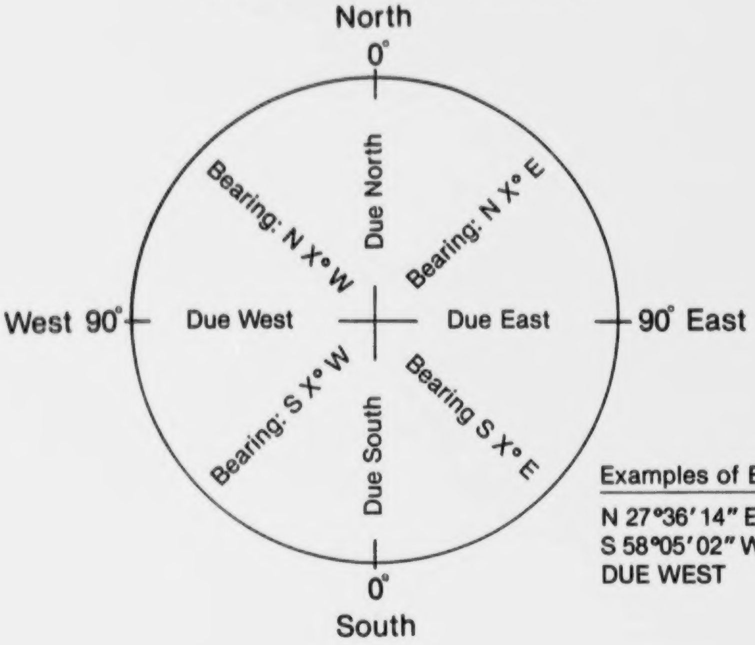
Loop Traverse

Connecting Traverse

Closed Traverses

Direction by Bearing or Azimuth

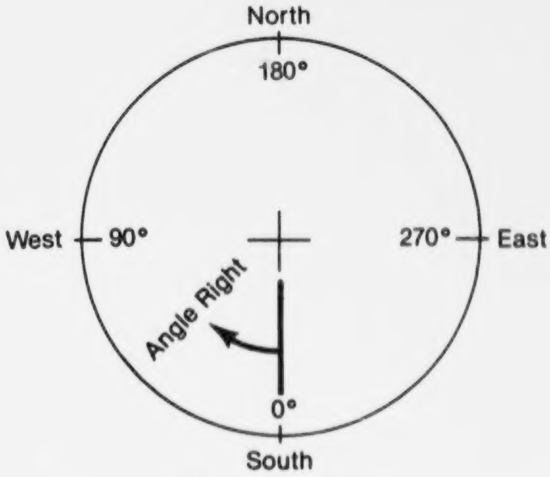
Direction by Bearing


North
0°
Due North
Bearing: N X° W
Bearing: N X° E
West 90°
Due West
Due East
90° East
Bearing: S X° W
Bearing S X° E
Due South
0°
South

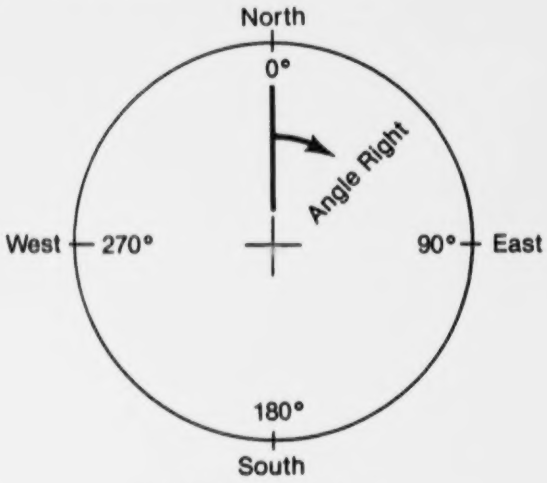
Examples of Bearings:

N 27°36′14″ E
S 58°05′02″ W
DUE WEST

Direction by Azimuth

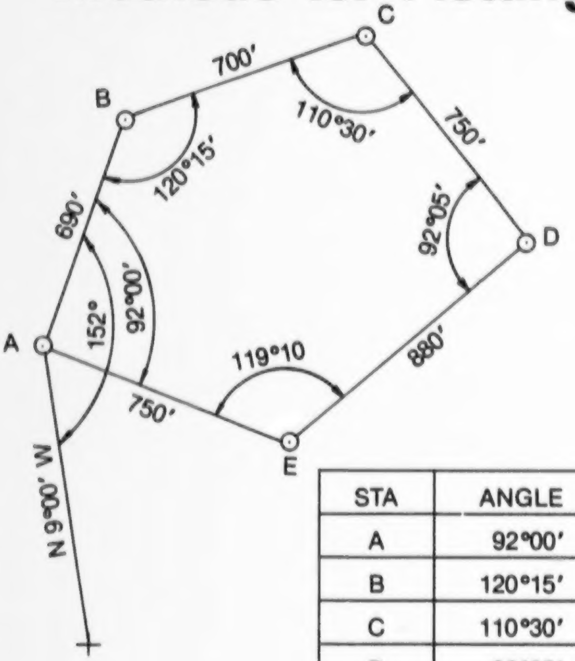

North
180°
West
90°
270°
East
Angle Right
0°
South

Azimuth South (Az_S)
Example: $Az_S = 246°07'53''$


North
0°
Angle Right
West
270°
90°
East
180°
South

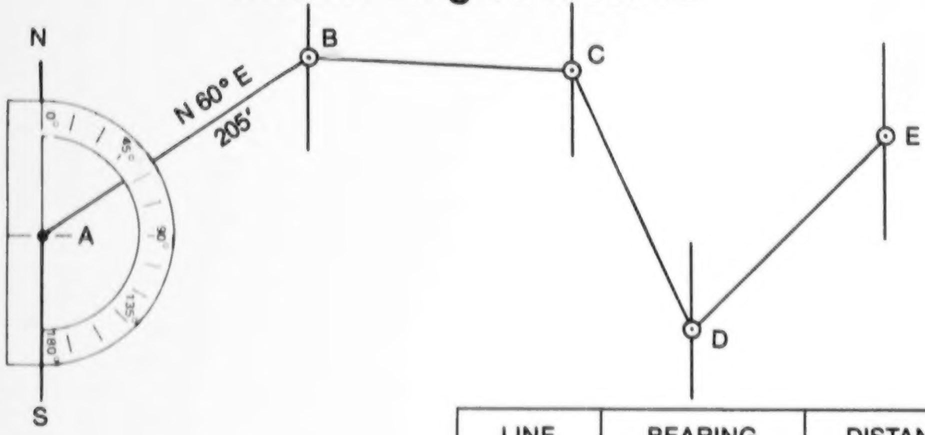
Azimuth North (Az_N)
Example: $Az_N = 66°07'53''$

Methods for Plotting Traverses


C
700'
B
110°30'
750'
120°15'
690'
92°05'
D
A
152°
92°00'
119°10
880'
750'
E
N 9°00' W

STA	ANGLE	COURSE	DIST
A	92°00'	AB	690'
B	120°15'	BC	700'
C	110°30'	CD	750'
D	92°05'	DE	880'
E	119°10'	EA	750'

Interior Angles Method

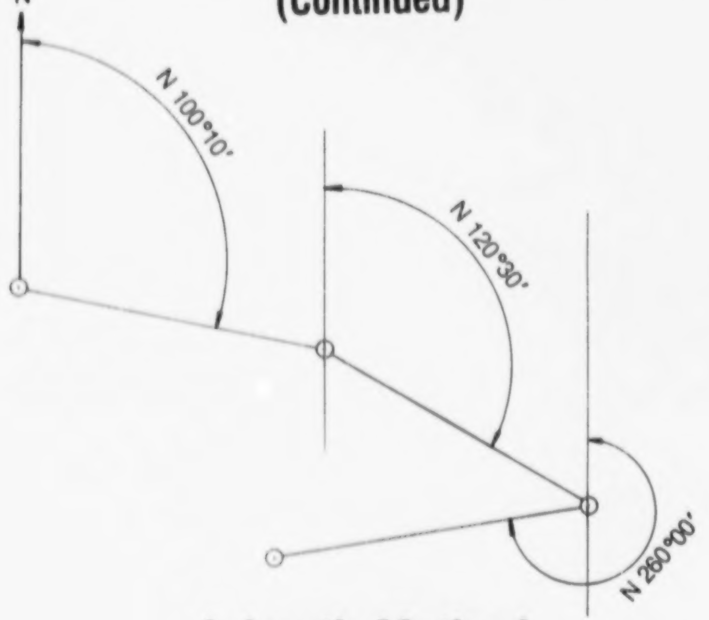

N
B
C
N 60° E
205'
E
0°
45°
A
90°
135°
180
D
S

LINE	BEARING	DISTANCE
AB	N 60° E	205'
BC	S 88° E	175'
CD	S 30° E	180'
DE	N 45° E	170'

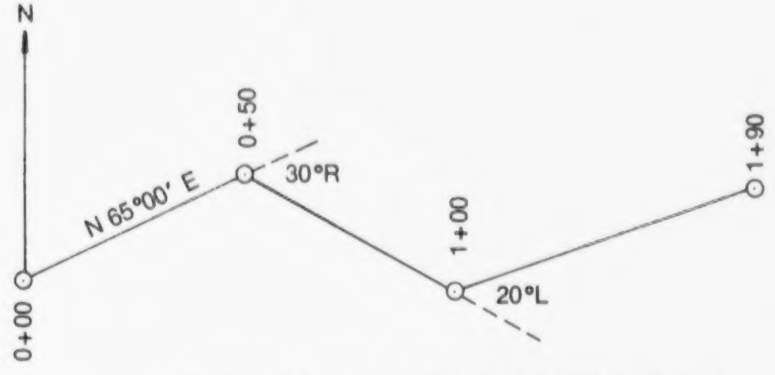
Distance and Bearing Method

Methods for Plotting Traverses

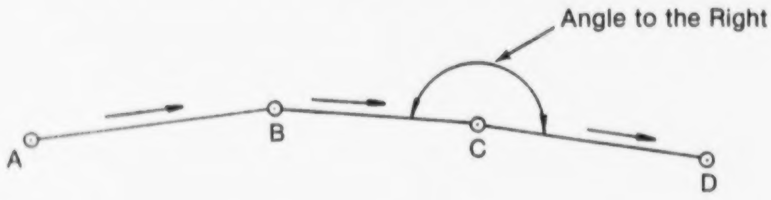
(Continued)


N
N 100°10'
N 120°30'
N 260°00'

Azimuth Method


N
N 65°00' E
0+00
0+50
30°R
1+00
20°L
1+90

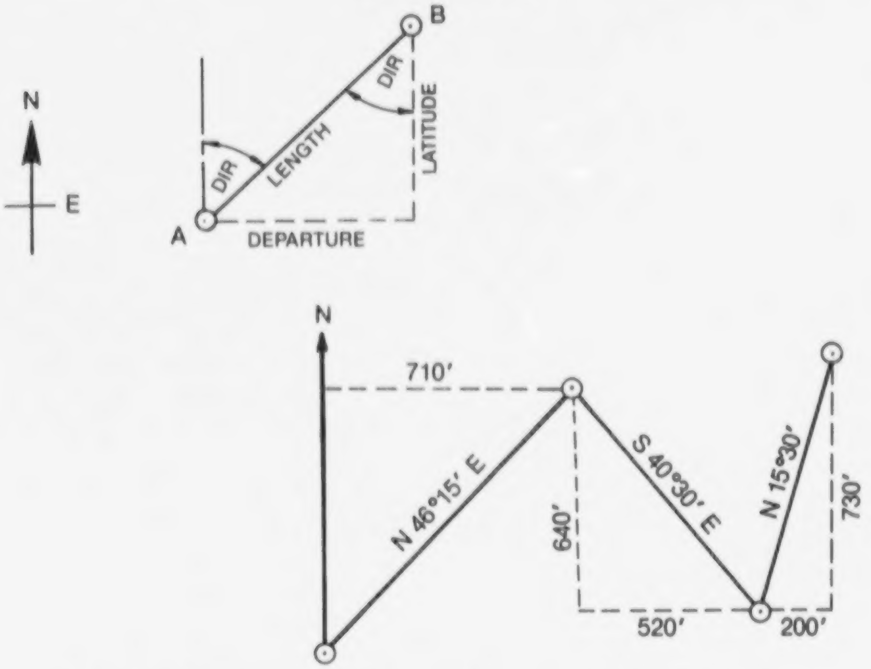
Deflection Angles Method


Angle to the Right
A
B
C
D

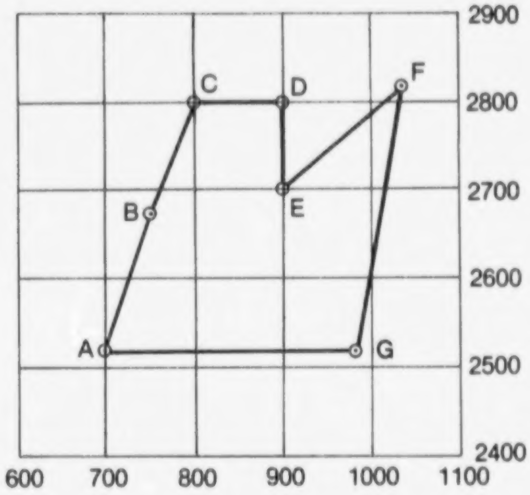
Angles-to-the-Right Method

Methods for Plotting Traverses

(Continued)


N
E
A
B
DIR
LENGTH
DIR
LATITUDE
DEPARTURE
N
710′
N 46°15′ E
640′
S 40°30′ E
520′
N 15°30′
730′
200′

Latitudes and Departures Method



STA	X-COORD	Y-COORD
A	700	2519
B	750	2672
C	800	2800
D	900	2800
E	900	2700
F	1034	2819
G	981	2519

Rectangular Coordinates Method

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

ASSIGNMENT SHEET #1 — PLOT LINES AND DISTANCES USING SEVERAL METHODS

Directions: Layout the following problems on vellum with pencil. Discuss the appropriate scale to use with your instructor.

Problem 1: Plotting a traverse by deflection angles

NOTES FOR TRAVERSE 1

Station	Deflection angle	Bearing
29 + 18	End of line	
23 + 98	102°42′ L.	
17 + 26	66°21′ L.	
12 + 62	37°45′ L.	
5 + 25	34°30′ L.	
0 + 00		S 50°00′ E

Problem 2: Plotting a traverse by bearings

NOTES FOR TRAVERSE 2

Station	Bearing
25 + 20	End of line
20 + 60	S 45°00′ E
15 + 97	S 70°45′ E
11 + 25	N 80°30′ E
7 + 45	S 81°20′ E
3 + 95	N 83°30′ E
0 + 00	N 60°00′ E

ASSIGNMENT SHEET #1

Problem 3: Plotting a traverse by latitudes and departures

NOTES FOR TRAVERSE 3

Course	Bearing	Length Chains	Latitude Chains	Departure Chains
5-6	S 30°45′ W	5.53	-4.75	-2.83
4-5	S 70°15′ E	7.77	-2.63	+7.31
3-4	N 25°30′ E	4.62	+4.17	+1.99
2-3	S 65°30′ E	5.25	-2.18	+4.78
1-2	N 45°00′ E	6.00	+4.24	+4.24

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

ASSIGNMENT SHEET #2 — CONVERT AZIMUTHS TO BEARINGS AND BEARINGS TO AZIMUTHS

Directions: Convert the following bearings to azimuths north or south or azimuths to bearings as directed. Plot all answers in the spaces provided using a scale of 1" = 50 ft and a length of line as 100 ft. Label the line with the appropriate answers.

Problem 1: Convert bearings to azimuths north.

Problem	*Bearing*
1a	S 79°24′ E
1b	N 41°59′ W
1c	N 12°57′ E
1d	S 80°48′ E

1a

1b

1c

1d

ASSIGNMENT SHEET #2

Problem 2: Convert bearings to azimuths south.

Problem	*Bearing*
2a	S 16°56′ E
2b	S 01°59′ W
2c	N 79°11′ W
2d	S 43°08′ E

2a

2b

2c

2d

Problem 3: Convert azimuths to bearings. Label the line with the true bearing.

Problem	*Azimuth (N)*
3a	144°51′
3b	217°24′
3c	185°37′
3d	346°14′

3a

3b

3c

3d

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

ASSIGNMENT SHEET #3 — LAYOUT A CLOSED TRAVERSE

Given: Field notes for a closed traverse. Distances were measured in the field and direction of each line was measured by an azimuth from the north. The field notes are from a traverse that has been adjusted to give mathematical closure and the resulting plotted traverse should return to the point of beginning.

Directions:

1. Use a scale of 1" = 100' and "C" size vellum and pencil.
2. Plot this traverse by use of the distances and calculated bearings shown in column 2 and column 6 of the given field notes.
3. Begin traverse at point M at approximately 1 inch from the top of your sheet and 1/2 inch from the left. The first line of the traverse begins at point "M" and extends to point 13 488.32 feet at a bearing of S 83°56' E.
4. After laying out the closed traverse, label all lengths by bearing and distance and label each station. Use 1/16 open circle to locate each station.

Explanation for column headings in the field notes

Column 1 — "Sta." — Station at which the surveying instrument is set up. (Transit in this example.)

Column 2 — "Obj." — This column gives the object to which the measurement was made.

Column 3 — "Dist Ft" — The distance between each point on the traverse.

Column 4 — "Azimuth" — The direction of each line measured by an azimuth from the north.

Column 5 — "Mag. B" — The compass bearing for each line recorded as a check on mistakes in recording or reading the azimuths.

Column 6 — "Cal. B" — The calculated bearings for each line that was obtained from converting the azimuths to bearings.

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Notes for Plate 2

Azimuth Control Traverse

Sta.	Obj.	Dist. Ft.	Azimuth	Mag. B	Cal. B.
M	N		150°23'	S29½°E	S29°37'E
	13	488.32	96°04'	S84°E	S83°56'E
13	M		276°04'	N84°W	N83°56'W
	14	545.44	93°01'	S87°E	S86°59'E
14	13		273°01'	N87°W	N86°59'W
	15	525.88	82°19'	N82¼°E	N82°19'E
15	14		262°19'	S82¼°W	S82°19'W
	16	134.95	82°49'	N82½°E	N82°49'E
16	15		262°49'	S82½ W	S82°49'W
	T	98.51	108°11'	S71½°E	S71°49'E
T	16		288°11'	N71½°W	N71°49'W
	U	403.97	184°52'	S5°W	S4°52'W
U	T		4°52'	N5°E	N4°52'E
	V	195.57	178°40'	S1½°E	S1°20'E
V	U		358°40'	N1½°W	N1°20 W
	W	210.67	181°41'	S1½°W	S1°41'W
W	V		1°41'	N1½°E	N1°41'E
	X	76.26	184°57'	S5°W	S4°57'W
X	W		4°57'	N5°E	N4°57'E
	Y	706.96	277°24'	N82½°W	N82°36'W
Y	X		97°24'	S82½°E	S82°36'E
	Z	345.07	268°37'	S88½ W	S88°37'W

10

South City Park, Opelousas, La.

Gurley Transit
No. 601652

J. Zaranges, ⊼
A. Soileau, H.C.
G. Carrier, R.C.
June 17, 1964
Wx. Hot-Clear

Note
1. Azimuth from North
2. Azimuth of line M-13 determined with Gurley Solar Transit 112T, No. 600500
3. Declination determined to be 7½° East. Compass ring set for needle to read true bearings
4. Hubs set and tacked at corners.

ASSIGNMENT SHEET #3

Notes for Plate 2 con't.

Sta.	Obj.	Dist. Ft.	Az.	Mag. B	Cal. B.
Z	Y		88°37'	N88½°E	N88°37'E
	C	417.72	268°37'	S88½W	S88°37'W
C	Z		88°37'	N88½°E	N88°37'E
	B	228.73	359°20'	N0⅔°W	N0°40'W
B	C		179°20'	S0⅔°E	S0°40'E
	A	99.87	0°00'	North	North
A	B		180°00'	South	Sout
	N	383.47	332°45'	N27¼°W	N27°15W
N	A		152°45'	S27¼°E	S27°15'E
	M	191.33	330°23'	N29⅝°W	N29°37'W
M	N		150°23'	S29⅝°E	S29°37'E
	Az.	Error	0°00'		

Capped pipe set in concrete

Capped pipe set in concrete

ASSIGNMENT SHEET #3

CD-253

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

ASSIGNMENT SHEET #4 — COMPLETE A MATHEMATICAL CLOSURE OF A TRAVERSE

There will be times when platting a new subdivision or other parcel of land that an error will be indicated because of failure to close property and the drafter cannot find the error. In order to check the drafting, the traverse can be checked mathematically on paper indicating whether or not the bearings (or angles) and distances given are correct. This method can also be used in the case of a figure with any number of sides where all the sides but one are known to find the bearing and distance of the remaining side to close the figure.

Mathematical closure of a traverse is merely a system of converting each side of the figure (figure can contain any number of sides but they must all be straight lines) into either north or south bearings and east or west bearings.

Before proceeding with any traverse closure, the angles or bearings must be checked to see that the figure closes as far as angles are concerned. These angles should all be checked in the field by the survey crew before they return to the office and the error balanced.

The procedure for checking a traverse is as follows:

1. Check interior angles. Sum of interior angle = $(N - 2) \times 180°$.
2. Assume one side as being true north bearing unless bearings are already given.
3. Using balanced interior angles and side assumed as north, determine the bearing of the other sides. Be sure to recheck the bearing of the first side from the last side determined to eliminate errors.
4. Assign numerals in consecutive order from the point of beginning chosen (P.O.B.) for each angle point in traverse.
5. Fill in all known data on computation sheet (side, bearing, distance).
6. Calculate the sine and cosine for each side from bearing indicated.
7. Multiply the length of each side by the sine and insert the result in either the east or west Departure Column that matches the bearing.
8. Multiply the length of each side by the cosine and insert the result in either the north or south Latitude Column that matches the bearing.
9. Add up the north latitudes and compare this with the sum of the south latitudes. If the traverse is correct, the two will be equal.

ASSIGNMENT SHEET #4

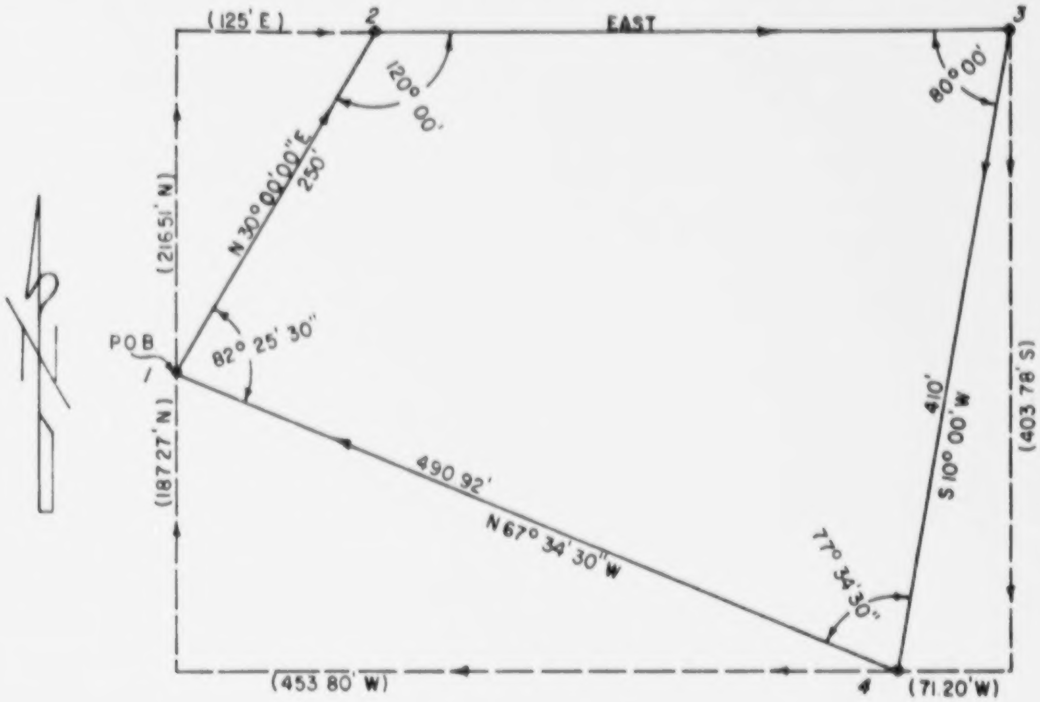
10. Add up the east departures and compare this with the sum of the west departures. They should also be equal.

11. Engineers and surveyors doing subdivision work generally use transits that read horizontal angles to the nearest minute or nearest 30 seconds. This means that when they balance their angles in the field, the resulting angles may be given to the nearest 15 or 30 seconds. The check of a closure is a simple process but care must be taken with decimal points and to see that the latitudes and departures are entered in the correct columns. Bearings are always given from north or south (unless due east or west) and are always less than 90°.

Example:

Traverse Closure

120° 00′
80° 00′ N − 2 (180) = 4 − 2 (180)
77° 34′30″ = 2 (180)
82° 25′30″
359° 59′60″ = 360° CHECK = 360°


(125' E)
2
EAST
3
120° 00'
80° 00'
N 30° 00' 00" E
250'
(216.51' N)
POB
1
82° 25' 30"
(187.27' N)
490.92'
N 67° 34' 30" W
77° 34' 30"
410'
S 10° 00' W
(403.78' S)
(453.80' W)
4
(71.20' W)

ASSIGNMENT SHEET #4

COURSE	DIST.	BEARING	SIN	COS	LAT.		DEP.	
					N (+)	S (−)	E (+)	W (−)
1								
	250.00	N30°00′ E	.500 00000	.866 02540	216.51		125.00	
2								
	400.00	Due East					400.00	
3								
	410.00	S10°00′ W	.173 64818	.984 80775		403.77		71.20
4								
	490.92	N67°34′30″W	.924 37967	.381 47375	187.27			453.80
1								
					403.78	403.77	525.00	525.00

12. Total Error (TE) = $\sqrt{(\text{Diff. in Lat.})^2 + (\text{Diff. in. Dep.})^2}$

13. Relative Error (Precision) = $\frac{\text{Total Error}}{\text{Total Dist.}} = \frac{1}{?}$

(NOTE: The degree of accuracy required of a survey is determined by the purpose of the survey.)

ASSIGNMENT SHEET #4

Assignment Problem:

1. Layout the following traverse.

Course	Bearing	Distance
A-B	N 48°20′ E	529.60
B-C	N 87°43′ E	592.0
C-D	S 7°59′ E	563.6
D-E	S 82°12′ W	753.4
E-A	N 48°12′ W	428.2

2. Using the completed traverse, calculate the mathematical closure of the traverse.

COURSE	DIST.	BEARING	SIN	COS	LATITUDE		DEPARTURE	
					N (+)	S (−)	E (+)	W (−)
A-B								
B-C								
C-D								
D-E								
E-A								

3. Calculate the total error and the relative error.

TE = ____________

RE = ____________

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

ASSIGNMENT SHEET #5 — REDUCE FOUR TYPES OF FIELD NOTES

Given: Examples of the following field notes and mathematical reductions for each type: Differential level notes, profile level notes, miscellaneous level shots at random, and cross section notes.

Directions: Study the examples for procedure and take the assigned field notes and mathematically reduce them.

TYPICAL FIELD NOTES: ***Differential level***
FIELD NOTES AS GIVEN TO THE DRAFTER BY THE SURVEYOR

ASSIGNMENT SHEET #5

①	SAMPLE : DIFFERENTIAL LEVEL					8-22-85 9:15 A.M.	CLOUDY, COOL, +68°, WINDY	CEC
	B.S.	H.I	FS	ROD	ELEV.			
BM_1	4.14				1000.00		ARBITRARY ELEV. SET ON TOP OF SPIKE IN	
TP_1			3.62				POWER POLE @ COR OF 2ND ST. & 10TH AVE. NW	
	5.44						(PAINTED ORANGE)	
TP_2			4.89					
	6.33							
TP_3			5.37					
	5.11							
$TBM_{(A)}$			5.06				SPIKE IN POWER POLE @ CORNER OF	
	5.16						MOUNTAIN ST. & CHARLES AVE.	
TP_4			4.88				(PAINTED ORANGE)	
	5.02							
TP_5			3.61					
	5.39							
TP_6			4.84					
	3.02							
BM_1	39.61		7.34				SAME AS STARTING BM DESCP. (CK BACK IN)	
			39.61					
	CK OK							

DRAFTER'S REDUCTION: ***Differential level***
FIELD NOTES AFTER THEY HAVE BEEN MATHEMATICALLY REDUCED BY THE DRAFTER

ASSIGNMENT SHEET #5

①	SAMPLE : DIFFERENTIAL LEVEL					8-22-85 9:15 A.M. CLOUDY, COOL, +68°, WINDY CEC
	B.S	H.I	FS	ROD	ELEV.	
BM_1	4.14	1004.14			1000.00	ARBITRARY ELEV SET ON TOP OF SPIKE IN
TP_1			3.62		1000.52	POWER POLE @ COR OF 2ND ST & 10th AVE NW
	5.44	1005.96				(PAINTED ORANGE)
TP_2			4.89		1001.07	
	6.33	1007.40				
TP_3			5.37		1002.03	
	5.11	1007.14				
$TBM_{(A)}$			5.06		1002.08	SPIKE IN POWER POLE @ CORNER OF
	5.16	1007.24				MOUNTAIN ST & CHARLES AVE
TP_4			4.88		1002.36	(PAINTED ORANGE)
	5.02	1007.38				
TP_5			3.61		1003.77	
	5.39	1009.16				
TP_6			4.84		1004.32	
	3.02	1007.34				
BM_1	39.61		7.34		1000.00	SAME AS STARTING BM DESCP (CK BACK IN)
			39.61			
	CK OK					

CHK OK
SAME AS STARTING ELEV.

Start with beginning BM, add the 1st Backsight (BS) to get your height of inst. (HI). Subtract your fore-sight (FS) from the HI to get ground elevation or turning point (TP) elev. Add the next BS to the last elev. to obtain your new HI. (Refer to Transparency Master 2)

TYPICAL FIELD NOTES: ***Profile level***
FIELD NOTES AS GIVEN TO THE DRAFTER BY THE SURVEYOR

ASSIGNMENT SHEET #5

②	SAMPLE: PROFILE LEVEL NOTES					8-22-85 9:45 AM CLOUDY, COOL, +65°, WIND	CEC
STA	BS	HI	FS	ROD	ELEV		
BM$_1$					1747.17	U.S.G.S BM # V-84 SET IN NOV 1964	
	5.18					(N.W CORNER SECT 5, T115N, R58W)	
0+00				5.02			
0+50				4.83			
1+00				4.71			
1+50				4.16			
2+00				3.58			
2+50				2.96			
TP$_1$			3.14				
	6.96						
3+00				6.25			
3+50				5.18			
4+00				4.87			
4+50				3.99			
5+00				3.30			
TP$_2$			5.88				
	2.10						
BM$_1$			5.22			SAME AS ABOVE	
	14.24	← →	14.24				
		CK OK				PROFILE SHOTS ON TWSP. ROAD ℄	
						RUNNING EAST FROM THE N.W. COR	
						OF SECT. 5, T115N, R58W.	

DRAFTER'S REDUCTIONS: ***Profile level***
FIELD NOTES AFTER THEY HAVE BEEN MATHEMATICALLY REDUCED BY THE DRAFTER

ASSIGNMENT SHEET #5

②	SAMPLE: PROFILE LEVEL NOTES					8-22-85 9:45 AM CLOUDY, COOL, +65°; WIND	CEC
STA.	BS	HI	FS	ROD	ELEV.		
BM1					1747.17	U.S.G.S. BM # V-84 SET IN NOV 1964	
	5.18	1752.35				(N.W. CORNER SECT 5, T115N, R58W)	
0+00				5.02	1747.33		
0+50				4.83	1747.52		
1+00				4.71	1747.64		
1+50				4.16	1748.19		
2+00				3.58	1748.77		
2+50				2.96	1749.39		
TP1			3.14		1749.21	*These elevations in turn would be plotted on profile paper. If plan/profile paper is required, you would need topo notes in addition to these.*	
	6.96	1756.17					
3+00				6.25	49.92		
3+50				5.18	50.99		
4+00				4.87	51.30		
4+50				3.99	52.18		
5+00				3.30	52.87		
TP2			5.88		1750.29		
	2.10	1752.39					
BM1			5.22		1747.17	SAME AS ABOVE	
	14.24 ←→		14.24		CK. OK.		
		CK OK				PROFILE SHOTS ON TWSP. ROAD ℄	
			SAME AS STARTING ELEV.			RUNNING EAST FROM THE N.W. COR.	
						OF SECT. 5, T115N, R58W	

TYPICAL FIELD NOTES: ***Miscellaneous level at random***
FIELD NOTES AS GIVEN TO THE DRAFTER BY THE SURVEYOR

ASSIGNMENT SHEET #5

③	SAMPLE: MISC LEVEL SHOTS @ RANDOM					8-22-85 10 35 AM	CLOUDY, +70° WINDY				CEC
STA	BS	HI	FS	ROD	ELEV.						
BM_1					5966.04	RR SPIKE IN POWER POLE IN FRONT OF					
	4.88					PADDOCK CENTER 805 GILLESPIE DR.					
				3.61		NW CORNER OF FOUNDATION ON SCHOOL					
				4.20		CURB AT FRONT ENTRANCE TO SCHOOL					
				4.00		℄ OF STREET 20' OUT FROM CURB SHOT					
TP_1			2.66								
	5.39										
				3.72		BOTTOM OF LOADING DOCK (BY BACK DOOR)					
				1.48		TOP OF	"	"	"	"	"
TP_2			5.81								
	1.96										
BM_1			3.76			SAME AS ABOVE					
	12.23	←→	12.23								
		CK OK									

DRAFTER'S REDUCTIONS: ***Miscellaneous level at random***
FIELD NOTES AFTER THEY HAVE BEEN MATHEMATICALLY REDUCED BY THE DRAFTER

ASSIGNMENT SHEET #5

③	SAMPLE: MISC LEVEL SHOTS @ RANDOM					8-22-85 10 35 AM CLOUDY, 70°, WINDY CEC
STA	BS	HI	FS	ROD	ELEV.	
BM_1					5966.04	RR SPIKE IN POWER POLE IN FRONT OF
	4.88	5970.92				PADDOCK CENTER 805 GILLESPIE DR.
				3.61	67.31	NW CORNER OF FOUNDATION ON SCHOOL
				4.20	66.72	CURB AT FRONT ENTRANCE TO SCHOOL
				4.00	66.92	℄ OF STREET 20' OUT FROM CURB SHOT
TP_1			2.66		5968.26	
	5.39	5973.65				
				3.72	69.93	BOTTOM OF LOADING DOCK (BY BACK DOOR)
				1.48	72.17	TOP OF " " " " "
TP_2			5.81		5967.84	
	1.96	5969.80				
BM_1			3.76		5966.04	SAME AS ABOVE
	12.23	← →	12.23		CK. OK.	
		CK OK				
			SAME AS STARTING ELEV.			

TYPICAL FIELD NOTES: ***Cross section***
FIELD NOTES AS GIVEN TO THE DRAFTER BY THE SURVEYOR

ASSIGNMENT SHEET #5

④ SAMPLE: CROSS SECTION NOTES

8-26-85
10:30 A M.
SUNNY, BREEZY +70°
OEC

STA	BS	HI	FS	ROD	ELEV.	SHOTS WEST	℄	SHOTS EAST
BM,					4930.22			
	5.22							
0+00						$\frac{4.6}{50'}$ $\frac{4.7}{25}$	$\frac{4.8}{0}$	$\frac{4.9}{25'}$ $\frac{5.0}{50'}$
0+24						$\frac{6.0}{30}$ $\frac{6.2}{25'}$, $\frac{8.4}{20'}$ $\frac{7.9}{16'}$, $\frac{5.3}{12}$	$\frac{5.1}{0}$	$\frac{5.3}{12'}$ $\frac{8.0}{15'}$ $\frac{8.6}{21'}$ $\frac{6.6}{26'}$ $\frac{6.8}{50'}$
0+50						$\frac{6.2}{30}$ $\frac{6.5}{26}$ $\frac{8.6}{21}$ $\frac{8.2}{16}$ $\frac{5.5}{12}$	$\frac{5.3}{0}$	$\frac{5.6}{12}$ $\frac{8.2}{15}$ $\frac{8.9}{22}$ $\frac{6.2}{25}$ $\frac{6.4}{50}$
1+00						$\frac{6.3}{30}$ $\frac{6.7}{25}$ $\frac{8.8}{20}$ $\frac{8.4}{16}$ $\frac{5.8}{12}$	$\frac{5.7}{0}$	$\frac{5.8}{12}$ $\frac{8.4}{15}$ $\frac{8.9}{21}$ $\frac{6.9}{26}$ $\frac{6.3}{30}$
			6.03					
	4.97							

DRAFTER'S REDUCTIONS: ***Cross section***
FIELD NOTES AFTER THEY HAVE BEEN MATHEMATICALLY REDUCED BY THE DRAFTER

ASSIGNMENT SHEET #5

④ SAMPLE: CROSS SECTION NOTES

8-26-85
10:30 A.M. SUNNY, BREEZY +70°

CEC

STA	BS	HI	FS	ROD	ELEV.
BM1					4930.22
	5.22	4935.44			
0+00					
0+24					
0+50					
1+00					
			6.03		4929.41
	4.97	4934.38			

This HI is transferred over here simply for understanding.

4935.44

	SHOTS WEST					℄	SHOTS EAST				
0+00			30.8 4.6/50'		30.7 4.7/25'	30.6 4.8/0		30.5 4.9/25'	30.4 5.0/50'		
0+24	29.4 6.0/50	29.2 6.2/25'	27.0 8.4/20'	27.5 7.9/16'	30.1 5.3/12	30.3 5.1/0	30.1 5.3/12'	27.4 8.0/15'	26.8 8.6/21'	28.9 6.5/26'	29.2 6.2/50'
0+50	29.2 6.2/50	28.9 6.5/25	26.8 8.6/21	27.2 8.2/16	29.9 5.5/12	30.1 5.3/0	29.8 5.6/12	27.2 8.2/15	26.5 8.9/22	28.6 6.8/25	29.0 6.4/50
1+00	29.1 6.3/50	28.7 6.7/25	26.6 8.8/20	27.0 8.4/16	29.6 5.8/12	29.7 5.7/0	29.6 5.8/12	27.0 8.4/15	26.5 8.9/21	28.5 6.9/26	29.1 6.3/30

Elev., not incl. the 4900

Rod Reading

Dist. from ℄

Most of the time, the last part of the elevation is used.

4934.38

This would be the "HI" for the next series of shots (X-sect.)

The notes would go on from here in the same style and check back in to BM, at the end to ensure closure.

ASSIGNMENT SHEET #5

Problem 1: Mathematically reduce the following field notes. Show your figures in red pencil.

⑫		MISC LEVEL SHOTS @ RANDOM				9-10-85 2:30 P.M. CLEAR, 75°, CALM	T.S. F.G.
STA	BS	HI	FS	ROD	ELEV.		
BM$_1$					6324.49		N.W. CORNER OF LIGHT POLE ON THE
	5.02						CORNER OF 7th ST. AND 4th AVE SW
				2.31			TOP NUT OF FIRE HYDRANT
				1.36			N TAN. SW CORNER OF 7th ST & 4th AVE.
				2.55			SE CORNER OF SLAB OF MAILBOX (702)
TP$_1$			1.06			(ROCK)	
	4.28						
				3.44			N INT OF DRWY AND CURB (716)
				1.26			NW CORNER OF FIRST STEP (711)
TP$_2$			4.32			(CURB)	
	.79						NUMBERS IN PARENTHESIS ARE
BM$_1$			4.71			(SAME AS ABOVE)	HOUSE NUMBERS
	10.09	←——→	10.09				
		CK OK					

ASSIGNMENT SHEET #5

Problem 2: Mathematically reduce the following field notes. Show your figures in red pencil.

(14) DIFFERENTIAL LEVEL NOTES

10-21-85
8:05 AM
CLOUDY, WINDY + 38°

CEC
RLS

STA	BS	HI	FS	ROD	ELEV	
BM$_1$					1000.00	ARBITRARY ELEV. SET ON TOP NUT OF F.H. @
	2.55					CORNER OF 3RD AVE NORTH & 12th ST. WEST
TP$_1$			2.78			SHOT ON CURB
	2.98					
TP$_2$			3.28			STREET LIGHT BASE
	3.92					
TP$_3$			4.79			ON CURB
	5.04					
TBM$_1$			5.11			"X" ON N.W. COR. OF FRONT STEP - ENTRANCE
	5.18					TO SCHERTZ MANUFACTURING
TP$_4$			5.09			F.H.
	5.03					
TP$_5$			4.77			CURB
	4.12					
TP$_6$			3.50			CURB
	2.95					
BM$_1$			2.45			SAME AS ABOVE - CHECKED BACK IN.
	31.77		31.77			

CK OK

Problem 3: Mathematically reduce the following field notes. Show your figures in red pencil.

ASSIGNMENT SHEET #5

⑯	CROSS SECTION NOTES (Co Rd 19)					10-23-85 11:00 AM	SUNNY, CALM, + 65°							CEC RLS
STA	BS	HI	FS		ELEV	SHOTS N				℄	SHOTS S			
BM1					1742.20									
	4.62					BM1 IS NAIL IN P.P. @ INT. OF ROAD (PAINTED RED)								
0+00							4.8/50'		4.9/25'	5.2/0	5.1/25'		5.3/50'	
0+30						5.9/50	6.3/24'	5.9/18'	5.4/18'	4.2/0	4.3/10'	5.6/16	6.2/25'	5.2/30'
0+50						6.0/30'	6.2/25'	6.1/14'	5.6/13	4.5/0	4.6/11'	5.7/17	6.3/24'	5.4/30'
1+00						5.8/30'	6.0/24'	6.3/14'	5.7/12'	4.4/0	4.5/10'	5.8/17'	6.7/22'	5.8/30'
TP1			5.14			NAIL IN POWER POLE								
	4.16													
1+50						5.3/50'	5.9/26'	6.7/18'	5.6/10'	4.6/0	4.7/11'	5.7/14'	6.4/26'	6.3/30'
2+00						6.0/30'	6.7/27	6.8/20'	5.9/12	4.9/0	5.0/12'	6.0/20'	6.7/28'	5.4/30'
TP2			4.18			ROCK								
	5.24													
			4.70			SAME AS ABOVE								
	14.02		14.02											
		CK OK												

Problem 4: Mathematically reduce the following field notes. Show your figures in red pencil.

ASSIGNMENT SHEET #5

⑱	PROFILE LEVEL NOTES - 10th AVE. NW					8-25-85 9:00 A.M. SUNNY, WINDY, +42°	CEC RLS
STA.	BS	HI	FS	ROD	ELEV.		
BM1					1790.40	STREET LIGHT BASE @ COR. OF 10th AVE. N & 2ND ST. W.	
	5.22						
0+00				3.46			
0+50				4.14			
1+00				4.82			
1+50				5.29			
TP1			5.37			SHOT ON CURB	
	4.10						
2+00				4.88			
2+50				5.21			
3+00				5.96			
3+50				6.33			
TP2			6.05			SHOT ON DRIVEWAY	
	5.30						
4+00				4.94			
4+50				5.62			
TP3			5.10			SHOT ON CURB	
	6.55						
BM1			4.65			SAME AS ABOVE (CHECKED IN)	
	21.17		21.17				
		CK OK					

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

ASSIGNMENT SHEET #6 — DRAW A MAP USING BEARINGS, DISTANCES, AND COORDINATES

Problem 1: Bearings, distances, and coordinates

Of the six Missile Complexes in the Southwest area, now all abandoned, Complex 2A is located near a north-south county road about 12 miles south of Prairie, Colorado on an old bombing range. The Complex consists of three missile silos, associated equipment and propellent terminals, the power house and control center, and the two antenna terminals. The missile silos, the entrance portal, and the antennae are visible on the ground surface. All other facilities, including the interconnecting tunnels, are below ground. The missile silos are 155 feet deep.

Plot the missile complex property boundary from the following bearings and distances. It is suggested the first course commence at a point on an 18" x 24" sheet of paper, 8 inches up and 4 inches to the left of the lower right hand corner, with the long paper dimension arranged vertically. The boundary is to be indicated by long lines broken at intervals by two dots, the standard right-of-way symbol. Coordinates, on an arbitrary base are given for selected property corners for checking purposes. Plot at a scale of one inch = 100 feet.

BOUNDARY:

POINT	BEARING	DISTANCE (ft)	COORDINATE
A	S 65°27′00″ W	621.00	N19,943.63 E43,571.30
B	N 84°53′00″ W	442.00	
C	N 38°22′00″ W	616.00	
D	N 26°25′01″ W	926.00	N21,037.31 E41,771.88 Closing
E	N 31°25′00″ E	923.00	
F	East	451.00	
G	S 61°53′00″ E	594.00	N21,545.07 E43,227.90 Closing
H	S 04°23′00″ E	1000.00	
J	N 85°37′00″ E	220.00	
K to A	S 04°23′00″ E	623.00	Closing line to Point A

INTERIOR FENCE:

POINT	BEARING	DISTANCE (ft)	COORDINATE
AA-BB	N 65°27′00″ E	455.00	AA — N 19,889.81 E 42,968.47
BB-CC	N 4°23′00″ W	295.00	
CC-DD	S 85°37′00″ W	240.00	
DD-EE	N 4°23′00″ W	1075.00	
EE-FF	N 61°53′00″ E	445.00	

ASSIGNMENT SHEET #6

POINT	BEARING	DISTANCE (ft)	COORDINATE
FF-GG	West	285.00	GG — N 21,636.23 E 42,360.84
GG-HH	S 31°25'00" W	705.00	
HH-JJ	S 24°09'25" E	744.27	
JJ-KK	S 55°95'13" E	165.00	
KK-LL			
LL-AA	S 84°53'00" E	300.00	Closing line to Point AA

COORDINATES OF SELECTED STRUCTURAL FEATURES:

Feature	Northing	Easting	Approximate Diameter
Launcher No. 1			
Center of missile silo	21,022.23	42,276.55	40 ft.
Center of equip. term.	21,069.43	42,346.03	40 ft.
Center of prop. term.	20,938.16	42,273.54	37.5 ft.
Launcher No. 2			
Missile silo	21,378.43	42,494.17	40 ft.
Equipment terminal	21,425.63	42,563.65	40 ft.
Propellant terminal	21,294.36	42,491.16	37.5 ft.
Launcher No. 3			
Missile silo	21,206.86	42,737.40	40 ft.
Equipment terminal	21,254.06	42,806.88	40 ft.
Propellant terminal	21,122.79	42,734.39	37.5 ft.
Antennae			
Center of No. 1	20,168.07	42,809.17	28 ft.
Center of No. 2	20,163.26	42,862.95	28 ft.
Center Point of			
Control center	20,680.69	42,562.03	105 ft.
Power house	20,758.97	42,756.89	125 ft.
Portal	20,692.94	42,686.43	35 ft.

ASSIGNMENT SHEET #6

Problem 2: Tunnel geometry — stationing

A system of tunnels connects all the facilities shown on the plan assembled as Problem 1. The tunnels are between 43 ft. and 57 ft. below ground surface.

The tunnel stationing commences as 0+00.00 midway on a line joining the centers of the two antennae at coordinates N20,165.67 E42,836.06. Tunnel width between the antennae is 15 ft. This width extends to station 0+50.00 on a line at right angles to the line joining the antennae centers. At this station the width narrows to 10 ft. and the tunnel direction changes. Tunnel geometry from this point northward is given below:

TUNNEL CENTERLINE CHAINING STATION TO STATION		BEARING	COORDINATES AT BEGINNING OF COURSE		TUNNEL WIDTH IN FT
			NORTHINGS	EASTINGS	
0+50.00	7+21.48	N21°53'10"W	20,215.47	42,840.52	10', to 5+69.50; 6+54.50 to 7+21.48
7+21.48	11+00.43	N6°53'10"W	20,838.55	42,590.21	10', 7+21.48 to 8+21.95; 8+57.28 to 9+31.76; 10+11.43 to 11+00.43
11+00.43	12+92.14	N5°06'50"E	21,214.76	42,544.76	10', 11+00.43 to 11+58.93; 11+90.93 to 12+43.93; 12+74.93 to 12+92.14
Line joining centers of power house and control center					15'
8+39.63	10+54.04	S83°06'50"W	20,955.85	42,576.05	10', 9+01.62 to 10+54.04;
10+54.04	Propellant Terminal No. 1				10', 10+54.04 to 10+67.54; 10+99.54 to P.T. No. 1
10+83.54	Equipment Terminal No. 1	N5°06'50"E	20,932.77	42,333.80	10', 10+99.53 to 11+51.54; 11+83.54 to E.T. No. 1
11+67.54	Missile Silo #1		21,016.43	42,341.29	M.S. No. 1 Easterly 29 ft.
9+49.44	10+84.04	N83°06'50"E	21,064.86	42,562.88	10', 10+11.43 to 10+84.04
10+84.04	11+78.54	S84°53'10"E	21,081.00	42,706.52	10', 10+84.04 to 11+62.54
11+78.54	Equipment Terminal No. 3		21,072.58	42,790.64	10', 12+39.54 to 12+91.54; 13+23.54 to E.T. No. 3
12+23.54	Propellant Terminal No. 3	21,117.40	42,794.65	10' for 25 ft. east of P.T. No. 3	
13+07.54	Missile Silo No 3	21,201.07	42,802.14	10' for 29 ft. east of Missile Silo No. 3	
11+74.92	Propellant Terminal No. 2	21,288.97	42,551.42	10' for 25 ft. east of P.T. No. 2	
12+58.98	Missile Silo No 2	21,379.63	42,558.91	10' for 29 ft. east of Missile Silo No. 2	

Tunnel Junctions and Blast Locks are located on the centerlines previously plotted as follows: (15 ft width)

At N20,725.42 E42, 673.38 and southeasterly to the Portal Structure

Tunnel Junction No. 12 at Station 6+70.50 southeasterly for 20 ft. to a hydraulic control room (No details of this.)

ASSIGNMENT SHEET #6

Blast Lock No. 1 at Station 9+49.43

Blast Lock No. 2 at Station 9+39.63

Tunnel Junction No. 5 at Station 11+74.92

Tunnel Junction No. 4 at Station 12+58.93

Tunnel Junction No. 7 at Station 13+07.54

Tunnel Junction No. 2 at Station 10+83.54, Launcher No.1

Tunnel Junction No. 1 at Station 11+67.54, Launcher No.1

Tunnel Junction No. 8 at Station 11+78.54, Launcher No.3

Tunnel Junction No. 9 at Station 12+23.54, Launcher No.3

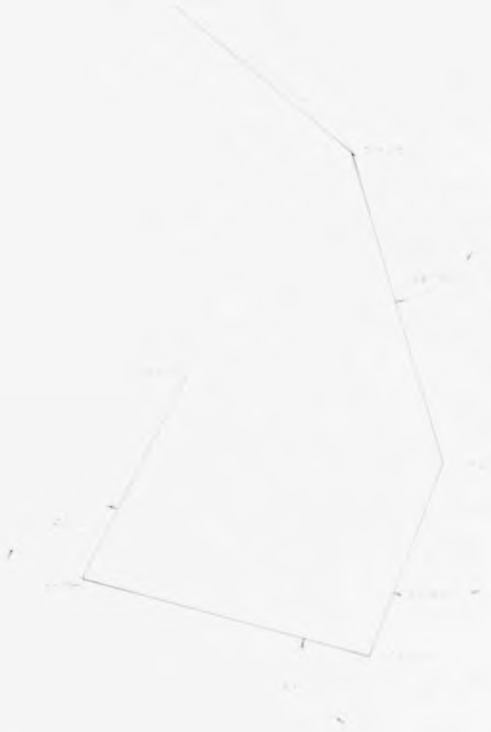
(NOTE: Roads will be added to this map in Unit IX, "Transportation Mapping," Assignment Sheet #2.)

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

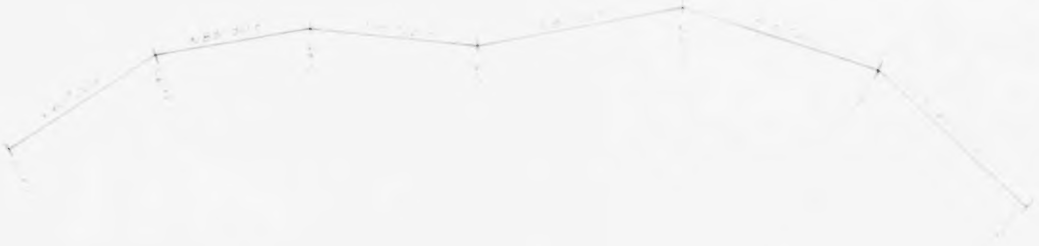
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

Problem 1: Deflection angles



Problem 2: Bearings

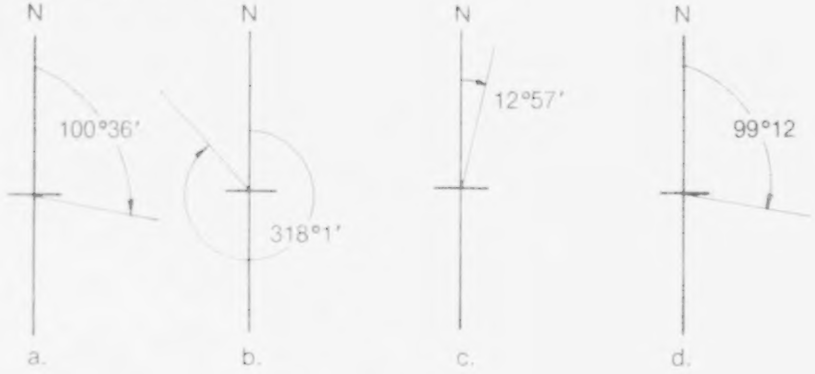


ANSWERS TO ASSIGNMENT SHEETS

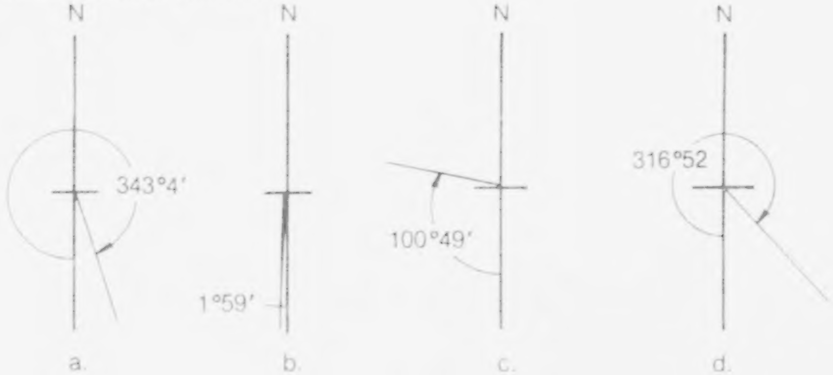
Problem 3: Latitudes and departures

Assignment Sheet #2

Problem 1: Bearings to azimuths (N)

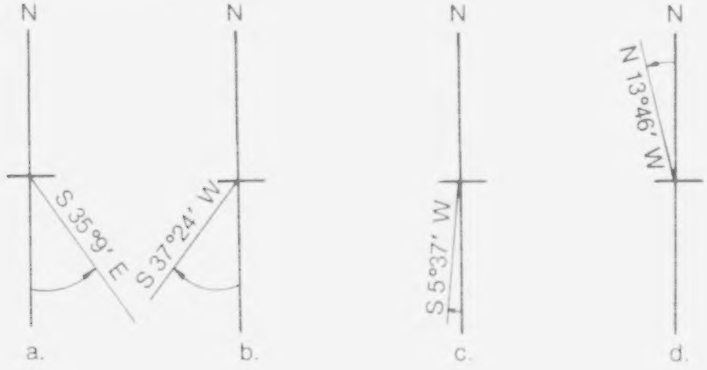

N
100°36′
a.
N
318°1′
b.
N
12°57′
c.
N
99°12
d.

Problem 2: Bearings to azimuths (S)

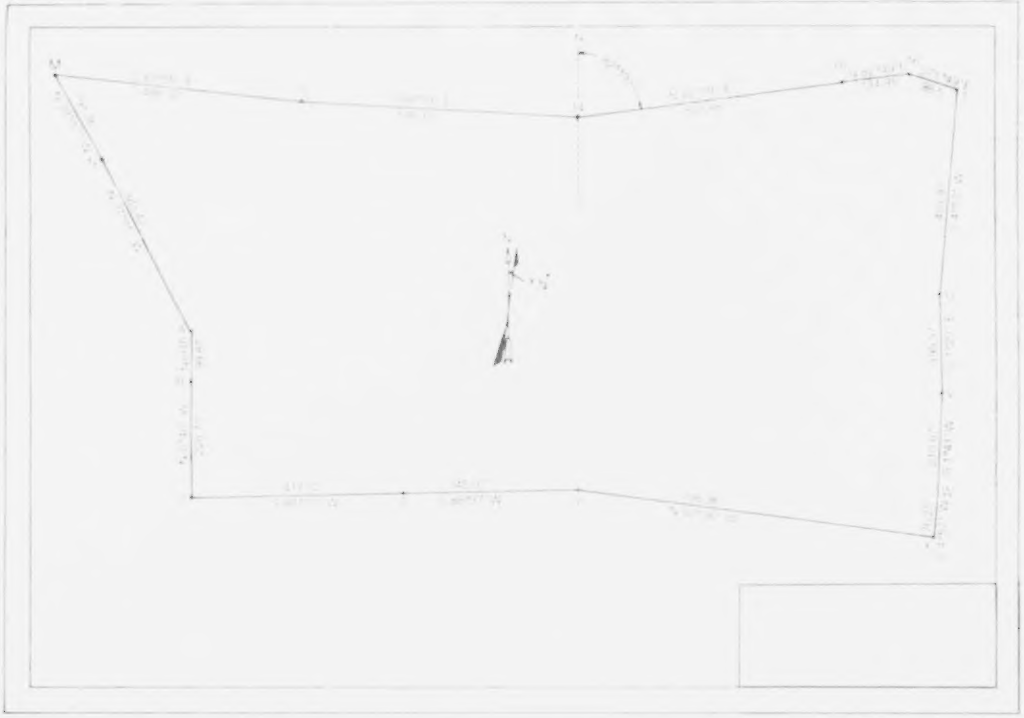

N
343°4′
a.
N
1°59′
b.
N
100°49′
c.
N
316°52
d.

ANSWERS TO ASSIGNMENT SHEETS

Problem 3: Azimuth to bearing


N
N
N
N
S 35°9' E
S 37°24' W
S 5°37' W
N 13°46' W
a.
b.
c.
d.

Assignment Sheet #3



ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

COURSE	DIST.	BEARING	SIN	COS	LATITUDE		DEPARTURE	
					N (+)	S (−)	E (+)	W (−)
A-B	529.60	N48°20′E			352.08		395.63	
B-C	592.0	N87°43′E			23.58		591.53	
C-D	563.6	S7°59′E				558.14	78.28	
D-E	753.4	S82°12′W				102.25		746.43
E-A	428.2	N48°12′W			285.41			319.21
					661.07	660.39	1065.44	1065.64
					−660.39			−1065.44
				Diff =	.68			.20

TE = $\sqrt{(.68)^2 + (.20)^2}$

TE = $\sqrt{(.46240) + (.04)}$

TE = $\sqrt{.50240}$ = .7088 = .71

Relative Error = $\frac{.71}{2866.8} \quad \frac{1}{4037.75}$

Error is 1′ in 4037.75′

Answers — Assignment Sheet #5
Problem 1: Miscellaneous level shots @ random

⑫ MISC LEVEL SHOTS @ RANDOM

9-10-85
2:30 PM
CLEAR, 75°, CALM

T.S.
F.G

STA	BS	HI	FS	ROD	ELEV.		
BM₁					6324.49		N.W. CORNER OF LIGHT POLE ON THE
	5.02	6329.51					CORNER OF 7th ST. AND 4th AVE SW
				2.31	6327.20		TOP NUT OF FIRE HYDRANT
				1.36	6328.15		N TAN. SW CORNER OF 7th ST & 4th AVE
				2.55	6326.96		SE CORNER OF SLAB OF MAILBOX (702)
TP_1			1.06		6328.45	(ROCK)	
	4.28	6332.73					
				3.44	6329.29		N INT OF DRWY AND CURB (716)
				1.26	6331.47		NW CORNER OF FIRST STEP (711)
TP_2			4.32		6328.41	(CURB)	
	.79	6329.20					NUMBERS IN PARENTHESIS ARE
BM₁			4.71		6324.49 CK OK	(SAME AS ABOVE)	HOUSE NUMBERS
	10.09	←→	10.09				
		CK OK		SAME AS STARTING ELEV.			

Problem 2: Differential level

⑭	DIFFERENTIAL LEVEL NOTES					10-21-85 8:05 A.M	CEC RLS
						CLOUDY, WINDY + 38°	
STA	BS	HI	FS	ROD	ELEV		
BM_1					1000.00	ARBITRARY ELEV. SET ON TOP NUT OF F.H. @	
	2.55	1002.55				CORNER OF 3RD AVE. NORTH & 12th ST. WEST	
TP_1			2.78		999.77	SHOT ON CURB	
	2.98	1002.75					
TP_2			3.28		999.47	STREET LIGHT BASE	
	3.92	1003.39					
TP_3			4.79		998.60	ON CURB	
	5.04	1003.64					
TBM_1			5.11		998.53	"X" ON N.W. COR. OF FRONT STEP-ENTRANCE	
	5.18	1003.71				TO SCHERTZ MANUFACTURING	
TP_4			5.09		998.62	F.H.	
	5.03	1003.65					
TP_5			4.77		998.88	CURB	
	4.12	1003.00					
TP_6			3.50		999.50	CURB	
	2.95	1002.45					
BM_1			2.45		1000.00	SAME AS ABOVE - CHECKED BACK IN.	
	31.77		31.77		CK OK		
		CK OK					
				SAME AS STARTING ELEV.			

Problem 3: Cross section

ANSWERS TO ASSIGNMENT SHEETS

⑯	CROSS SECTION NOTES (Co. Rd 19)					10-23-85 11:00 AM SUNNY, CALM, + 65° CEC RLS
STA	BS	HI	FS		ELEV	SHOTS N ℄ SHOTS S
BM_1					1742.20	
	4.62	1746.82				BM, IS NAIL IN PP @ INT OF ROAD (PAINTED RED)
0+00						$\frac{1746.82}{\wedge}$ 42.0 $\frac{4.8}{50'}$ 41.9 $\frac{4.9}{25}$ 41.6 $\frac{5.2}{0}$ 41.7 $\frac{5.1}{25}$ 41.5 $\frac{5.3}{50}$
0+30						40.9 $\frac{5.9}{50}$ 40.5 $\frac{6.3}{24}$ 40.9 $\frac{5.9}{18}$ 41.4 $\frac{5.4}{12}$ 42.6 $\frac{4.2}{0}$ 42.5 $\frac{4.3}{10'}$ 41.2 $\frac{5.6}{16}$ 40.6 $\frac{6.2}{23'}$ 41.6 $\frac{5.2}{50'}$
0+50						40.8 $\frac{6.0}{50}$ 40.6 $\frac{6.2}{25}$ 40.7 $\frac{6.1}{19'}$ 41.2 $\frac{5.6}{15}$ 42.3 $\frac{4.5}{0}$ 42.2 $\frac{4.6}{11'}$ 41.1 $\frac{5.7}{17}$ 40.5 $\frac{6.3}{24'}$ 41.4 $\frac{5.4}{50'}$
1+00						41.0 $\frac{5.8}{60'}$ 40.2 $\frac{6.6}{24}$ 40.5 $\frac{6.3}{19'}$ 41.1 $\frac{5.7}{12'}$ 42.4 $\frac{4.4}{0}$ 42.3 $\frac{4.5}{10'}$ 41.0 $\frac{5.8}{12}$ 40.1 $\frac{6.7}{22'}$ 41.0 $\frac{5.8}{50'}$
TP_1			5.14		1751.96	NAIL IN POWER POLE
	4.16	1746.74				
1+50						$\frac{1747.80}{\wedge}$ 42.5 $\frac{5.3}{50'}$ 41.9 $\frac{5.9}{28}$ 41.1 $\frac{6.7}{18}$ 42.2 $\frac{5.6}{10}$ 43.2 $\frac{4.6}{0}$ 43.1 $\frac{4.7}{11'}$ 42.1 $\frac{5.7}{19'}$ 41.3 $\frac{6.5}{26}$ 42.3 $\frac{5.3}{50'}$
2+00						41.8 $\frac{6.0}{50'}$ 41.1 $\frac{6.7}{27}$ 41.0 $\frac{6.8}{20'}$ 41.9 $\frac{5.9}{12}$ 42.9 $\frac{4.9}{0}$ 42.8 $\frac{5.0}{12'}$ 41.8 $\frac{6.0}{20'}$ 41.1 $\frac{6.7}{28}$ 42.4 $\frac{5.4}{50'}$
TP_2			4.18		1751.98	ROCK
	5.24	1746.74				
			4.70		1751.44	SAME AS ABOVE
	14.02		14.02			
		CK OK				

ANSWERS TO ASSIGNMENT SHEETS

Problem 4: Profile level

⑧ PROFILE LEVEL NOTES - 10th AVE NW

8-25-85
9:00 A.M. SUNNY, WINDY, +42°

CEC
RLS

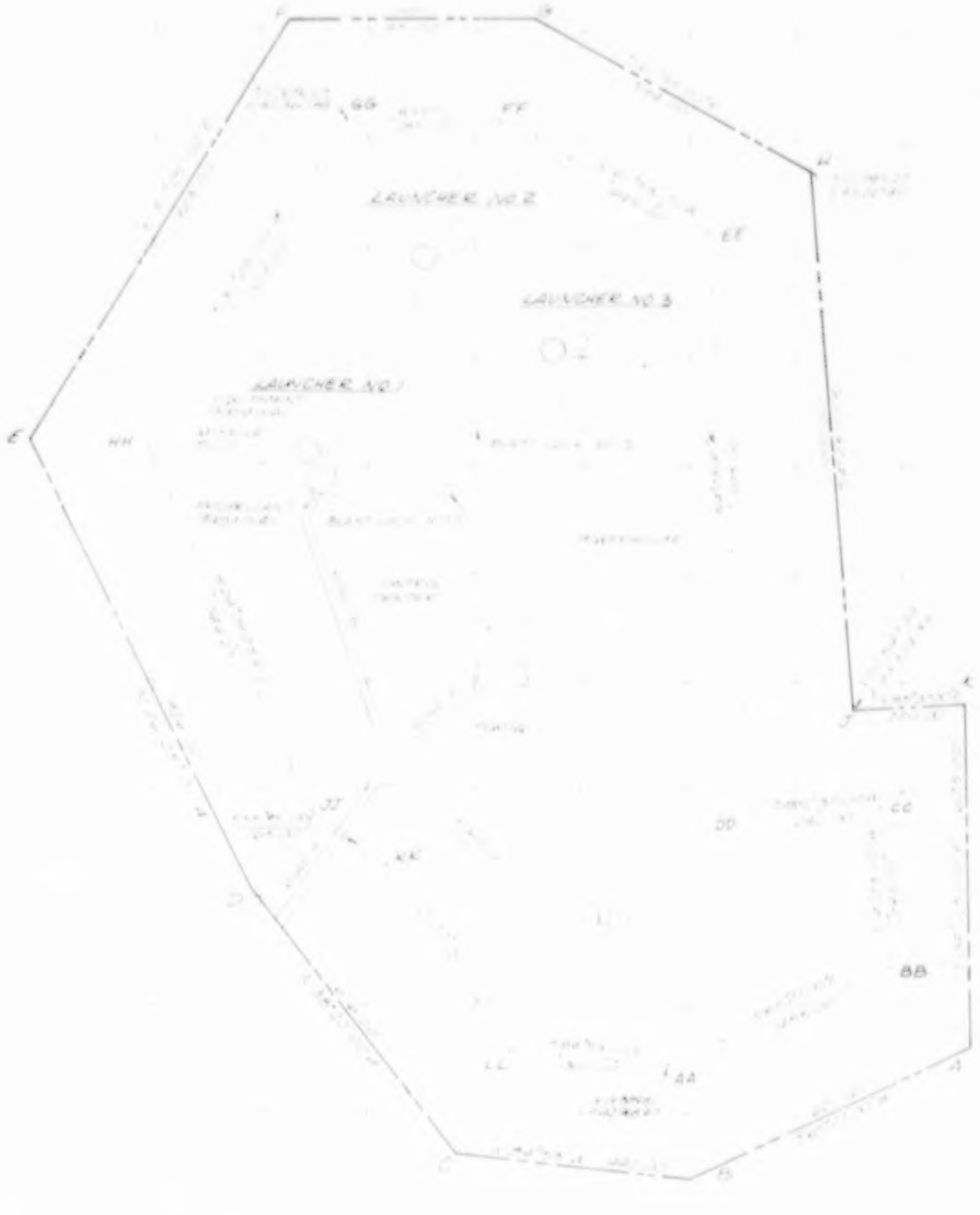
STA	BS	HI	FS	ROD	ELEV	
BM1					1790.40	STREET LIGHT BASE @ COR OF 10th AVE. N &
	5.22	1795.62				2ND ST W.
0+00				3.46	1792.16	
0+50				4.14	1791.48	
1+00				4.82	1790.80	
1+50				5.29	1790.33	
TP1			5.37		1790.25	SHOT ON CURB
	4.10	1794.35				
2+00				4.88	1789.47	
2+50				5.21	1789.14	
3+00				5.96	1788.39	
3+50				6.33	1788.02	
TP2			6.05		1788.30	SHOT ON DRIVEWAY
	5.30	1793.60				
4+00				4.94	1788.66	
4+50				5.62	1787.20	
TP3			5.10		1788.50	SHOT ON CURB
	6.55	1795.05				
BM1			4.65		1790.40	SAME AS ABOVE (CHECKED IN)
	21.17		21.17		CK OK	

CK OK

SAME AS STARTING ELEV.

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #6


F
G
GG
FF
H
LAUNCHER NO.2
EE
LAUNCHER NO.3
LAUNCHER NO.1
E
HH
J
K
JJ
KK
DD
CC
D
BB
LL
AA
A
C
B

INTERPRETATION OF SURVEYOR'S NOTATIONS
UNIT IV

NAME ____________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. The bearing or azimuth and length of a line

_____b. The difference in direction between two intersecting lines in a horizontal plane, two intersecting vertical planes, or two intersecting lines of sight

_____c. A surveying procedure used to determine the direction and length of a series of lines known as courses

_____d. Any numerical or geometric quantity or set of such quantities which may serve as a reference or base for other quantities

_____e. A number of points (called traverse stations) connected in series between horizontal angles by horizontal lengths; may be open or closed

_____f. The direction of the line expressed by the acute angle with respect to a reference meridian which can be a north or south

_____g. The horizontal direction reckoned clockwise from the meridian plane

_____h. Arbitrary points established in a survey usually located 100 feet apart

_____i. The vertical distance from a datum, generally mean sea level, to a point or object on the earth's surface

_____j. A relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known

_____k. Bearing of a station to a preceding station

1. Azimuth
2. Back bearing
3. Beaman arc
4. Bearing
5. Bench mark
6. Course
7. Datum
8. Elevation
9. Grid
10. Horizontal angle
11. Horizontal length

TEST

______l. The difference in direction between a horizontal plane and an intersecting line, plane, or a line of sight to a point

______m. The science of determining the dimensions and contours of the earth's surface by measurements of distances, directions, and elevations; computation of areas and volumes; and the preparation of necessary maps

______n. A series of connecting triangles in which a side of one and the angle of all are measured and the remaining sides are computed by trigonometry

______o. A substantial square stake, usually driven flush with the ground, with a tack marking the survey point

______p. The straight line distance measured in a horizontal plane

______q. A measurement of a difference in height or elevation

______r. A series of measured parallel and perpendicular reference lines laid out an equal distance apart to form equal squares

______s. The position of a point, line, traverse, triangulation, or grid can be defined by coordinates which are northerly or southerly, measured from an arbitrarily chosen east-west (x) axis, and easterly and westerly measured from an arbitrarily chosen north-south (y) axis

______t. A physical structure, such as an iron post, marked stone, or tree in place, which marks the location of a corner point established by a cadastral survey

______u. A specially graduated arc attached to the vertical circle of an alidade or transit to simplify computing elevation difference for inclined stadia sights

12. Hub
13. Latitude and departure
14. Monument
15. Station
16. Surveying
17. Traverse
18. Traversing
19. Triangulation
20. Vertical angle
21. Vertical length

TEST

2. Complete the following statements concerning survey methods to determine distance and positions of points by selecting the correct answers and placing them in the appropriate blanks.

_____a. When determining distances, _____ dimensions are measured.

1) 2
2) 3
1) 4
1) 6

_____b. Using tapes to determine horizontal lengths is an example of _____ method of measuring horizontal lengths.

1) Direct
2) Indirect
3) Combined direct and indirect

_____c. Aerial photographs and electronic devices are examples of _____ method of measuring horizontal lengths.

1) Direct
2) Indirect
3) Combined direct and indirect

_____d. Horizontal angles may be interior angles, exterior angles, angles to the left or right, and

1) Nadir angles
2) Zenith angles
3) Deflection angles
4) Traverse angles

_____e. Vertical angles are measured in the _____ plane in degrees of arc.

1) Horizontal
2) Vertical

_____f. The horizontal positions of points can be determined by all of the following methods **EXCEPT**

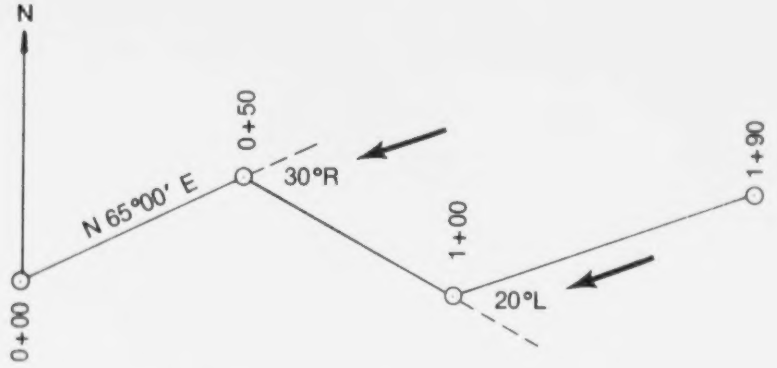
1) Traversing
2) Leveling
3) Triangulation
4) Azimuth and bearing

_____g. The vertical positions of points are determined from a series of _____ readings.

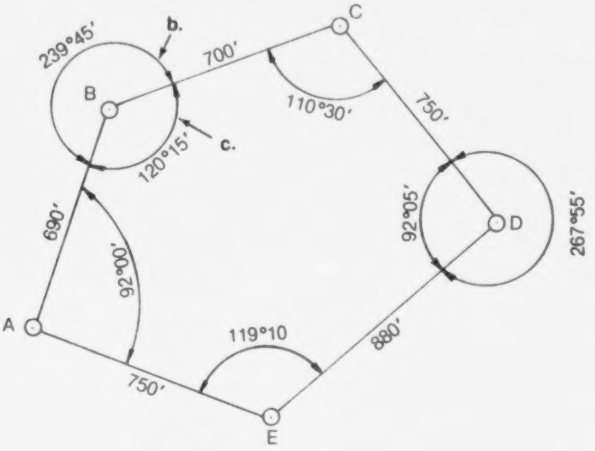
1) Stadia
2) Tape
3) Paced
4) Level

TEST

3. Identify the following types of horizontal and vertical angles and place your answers in the blanks provided.


N
N 65°00′ E
0+00
0+50
30°R
1+00
20°L
1+90

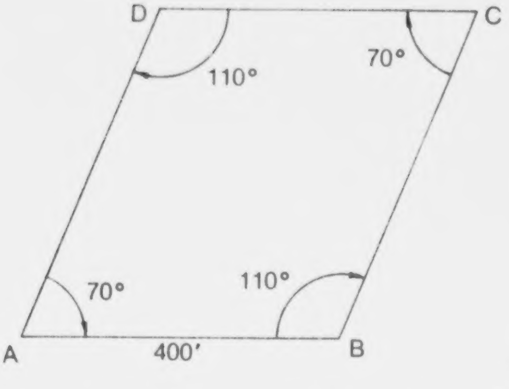
a. ______________________________

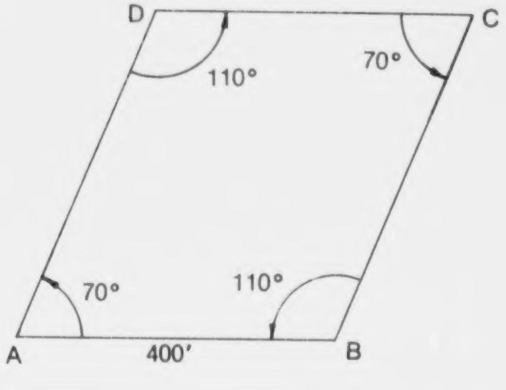

239°45′
b.
B
700′
C
110°30′
750′
c.
120°15′
92°05′
D
267°55′
690′
92°00′
A
119°10
880′
750′
E

b. ______________________________

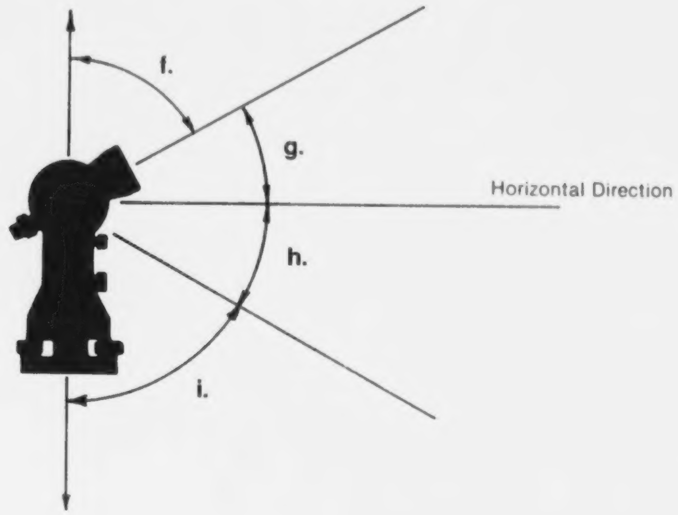
c. ______________________________

TEST


D
C
110°
70°
70°
110°
A
400′
B


D
C
110°
70°
70°
110°
A
400′
B

d. ______________________ e. ______________________


f.
g.
Horizontal Direction
h.
i.

f. ______________________ g. ______________________

h. ______________________ i. ______________________

TEST

4. Match principal surveying equipment on the right with the correct uses.

______a. A straight rod or bar with a flat face graduated in linear units with zero at the bottom, used in measuring the vertical distance between a point on the ground and the horizontal line of sight of a leveling instrument.

______b. Used for recording survey notes and layout and construction data.

______c. Used primarily for measuring horizontal and vertical angles, prolonging and setting points in line, measuring approximate distances by the stadia principles, and for leveling operations.

______d. Emits a signal of electromagnetic energy from one position to a receiver at another position. The signal is returned from the receiver to the instrument such that two times the distance between the two positions can be measured.

______e. Used to establish the elevation of different points on the ground; several types used.

______f. Used to measure horizontal distances; several types are used.

______g. Accomplishes the same tasks as a transit through optical means that are more accurate.

______h. Used for obtaining detail and topography.

1. Electronic distance-meter (EDM)
2. Field books
3. Level rod
4. Levels
5. Planetable and alidade
6. Tapes
7. Theodolite
8. Transit

TEST

5. Match types of surveys on the right with the correct descriptions of their uses.

_____a.
1) Locates property corners and boundary lines
2) Is normally a closed traverse because the survey always returns to the point of beginning (POB)

_____b. Locates elevations and features on the land, both natural and artificial

_____c.
1) Is a survey covering large areas
2) Is mapped by triangulation
3) The control established by this survey is often used as references for other surveys

_____d.
1) Photographs taken at various altitudes are the field notes for this survey
2) Measurements are taken using a stereoplotter from the photos of known distances on the ground

_____e. Is an open traverse that is run when mapping linear features such as highways, pipelines, or power lines

_____f. Is performed at a construction site to establish building lines, elevations of excavations, fills, foundations, and floors

1. Construction survey
2. Geodetic survey
3. Land or boundary survey
4. Photogrammetric survey
5. Route survey
6. Topographic survey

6. Select true statements concerning stationing by placing an "X" next to the true statements.

_____a. Survey distances are recorded by stations.

_____b. Distance between full stations is 10 feet.

_____c. A fractional part of a full station is called a plus station.

_____d. Beginning point in an open traverse is labeled station 10 + 00.

_____e. Stationing is generally laid out from west to east and south to north.

_____f. The marking stake set in the field by the survey crew indicates elevation and the hub indicates the station number.

TEST

7. Complete the following statements concerning field notes by circling the correct words.

   a. Are (**temporary, permanent**) records of work done in the field.

   b. The lettering style used to record notes is (**upper and lower case, all upper case**) sloped letters.

   c. Notes are lettered with a sharp (**soft, hard**) lead pencil.

   d. Erasures of observed data (**are, are not**) permitted.

   e. If an entire page is to be deleted, (**the page is torn out and discarded, diagonal lines are drawn through the page and "VOID" is lettered prominently with the reasons**).

   f. Field notes are recorded (**at the time of the survey, later in the office**) by a member of the survey crew.

   g. Field notes consist of numerical data, explanatory statements, and (**sketches, finished drawings**).

   h. The word (**"REPRINT", "COPY"**) should be lettered diagonally across pages that are nonoriginal notes.

   i. Each day's work starts (**where the last day ended, on a clean page**).

8. Select true statements concerning the arrangement of field notes in the field book by placing an "X" next to the true statements.

______a. All field books are arranged the same, regardless of the type of survey.

______b. Each book should be identified and indexed before recording notes.

______c. Left and right hand pages rarely correspond to each other.

______d. The symbol used to represent the instrument operator is

______e. Pages are numbered on each left-hand page. A single page number is used for both the right and left-hand sides.

______f. Notes are run down the page, except in route surveys where they are run up the page to conform with sketches.

______g. Descriptions and drawings should line up with corresponding numerical data.

______i. The left page of notes is generally gridded and is designed for sketches.

______j. Column headings on the left page are placed between the first two horizontal lines at the page top and follow from left to right in order of reading and recording.

TEST

9. Match methods of recording field notes listed on the right with the correct characteristics.

_____a.
1) Electronic theodolite, distance measuring units, and total station systems provide visually displayed digital readings.
2) Often field sketches and other handwritten information must still be recorded by hand because data may be accidentally erased by a magnetic field or faulty battery.

_____b. Can produce visual photographic records of monuments and other admissable field evidence.

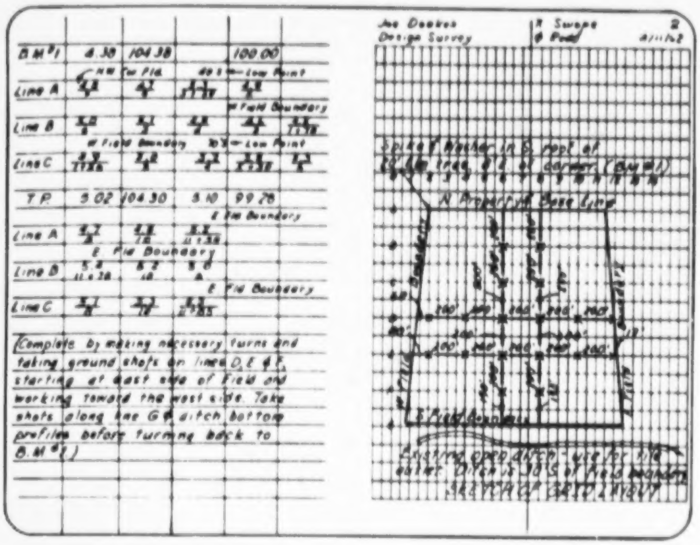
_____c.
1) Have a sewn binding, hard cover, and 80 leaves
2) Ensure maximum testimony acceptability for property survey records in courtrooms.

_____d.
1) Allow ready transfer of partial sets of notes between field and office.
2) Make it possible to use different ruling in the same book.
3) Make it possible to lose individual sheets.

1. Bound books
2. Loose-leak books
3. Electronic data recorders
4. Camera

TEST

10. Identify the following examples of different types of field notes. Choose from the following types: bench level circuit, profile and cross section, deflection angle traverse, stadia traverse, grid survey, planetable topography, and circular curves. Not all of these types will be shown.



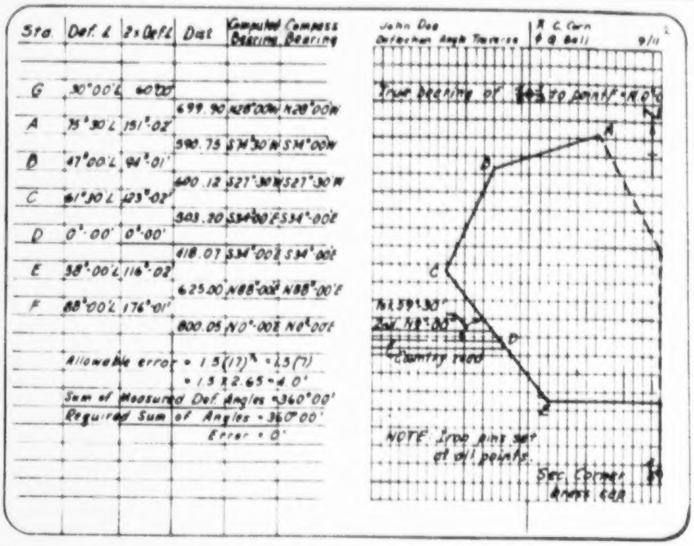
B.M.#1	4.38	104.38		100.00	
T.P.	3.02	104.30	3.10	99.28	

(Complete by making necessary turns and taking ground shots on lines D, E & F, starting at east side of field and working toward the west side. Take shots along line G & ditch bottom profiles before turning back to B.M.#1.)

Joe Doakes
Design Survey

Line A
Line B
Line C
Low Point
Field Boundary
N Property & Base Line
S Field Boundary
Existing open ditch - use for the outlet. Ditch is 30' S of field boundary.
SKETCH OF GRID LAYOUT

a. ______________________________



Sta.	Def. ∠	2×Def∠	Dist	Computed Bearing	Compass Bearing
G	30°00'L	60°00'			
			699.90	N28°00'W	N28°00'W
A	75°30'L	151°-02'			
			390.75	S74°30'W	S74°00'W
B	47°00'L	94°-01'			
			400.12	S27°30'W	S27°30'W
C	61°30'L	123°-02'			
			303.30	S34°00'E	S34°-00'E
D	0°-00'	0°-00'			
			418.07	S34°00'E	S34°00'E
E	58°-00'L	116°-02'			
			625.00	N88°00'E	N88°-00'E
F	88°00'L	176°-01'			
			800.05	N0°-00'E	N0°00'E

Allowable error = 1.5(17)^½ = 1.5(7)
= 1.5 × 2.65 = 4.0'
Sum of Measured Def. Angles = 360°00'
Required Sum of Angles = 360°00'
Error = 0'

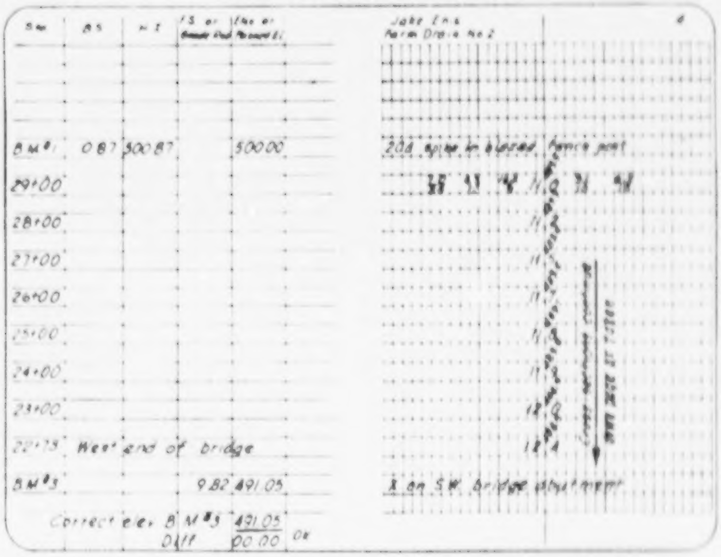
John Doe
Deflection Angle Traverse
R. C. Corn
G. Bell
9/11

True bearing of GA to point = N 0°
NOTE: Iron pins set at all points.
Sec. Corner

A
B
C
D
E
N
Country road

b. ______________________________

TEST



Sta	BS	HI	FS or Grade Rod	Elev or Ground El
BM#1	0 87	500 87		500 00
29+00				
28+00				
27+00				
26+00				
25+00				
24+00				
23+00				
22+75	West end of bridge			
BM#3			9 82	491.05
	Correct elev	B M#3		491.05
		Diff		00.00 OK

Jake Enis
Farm Drain No 2

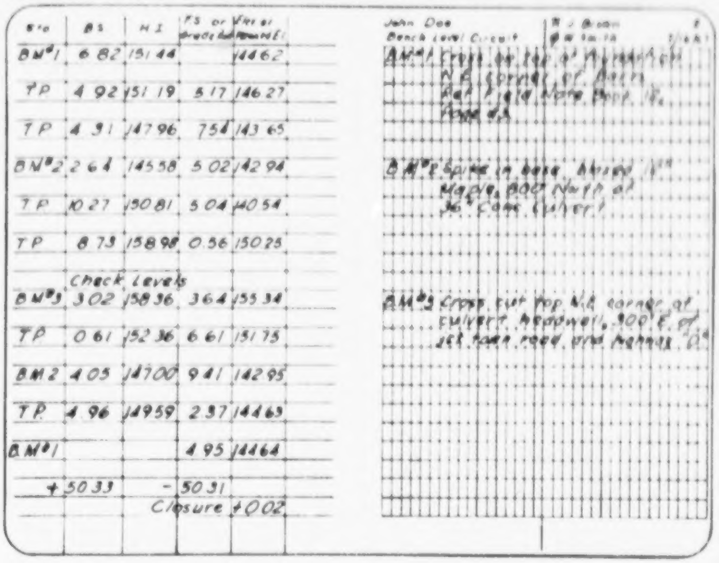
4

20d spike in blazed fence post

11 11 11 11 11 11 12 12

X on SW bridge abutment

c. ____________________



Sta	BS	HI	FS or Grade Rod	Elev or Ground El
BM#1	6 82	151 44		144 62
TP	4 92	151 19	5 17	146 27
TP	4 31	147 96	7 54	143 65
BM#2	2 64	145 58	5 02	142 94
TP	10 27	150 81	5 04	140 54
TP	8 73	158 98	0 56	150 25
	Check Levels			
BM#3	3 02	158 36	3 64	155 34
TP	0 61	152 36	6 61	151 75
BM 2	4 05	147 00	9 41	142 95
TP	4 96	149 59	2 37	144 63
BM#1			4 95	144 64
+	50 33	-	50 31	
		Closure		+0 02

John Doe
Bench Level Circuit

R J Brown
W Smith

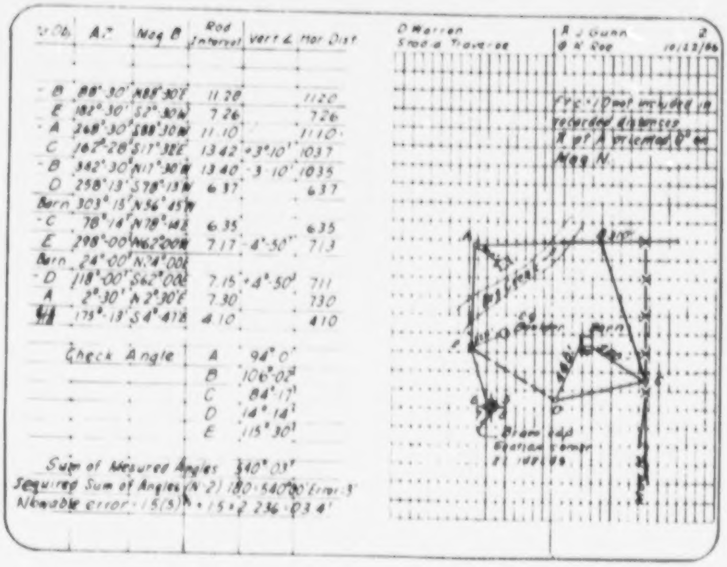
BM#1 Cross on top of [illegible] N.E. corner of [illegible] [illegible] [illegible] [illegible] Road 63

BM#2 Spike in base [illegible] Maple, 800' North of 36" Conc Culvert

BM#3 Cross cut top N.E. corner of culvert headwall, 300' E. of [illegible] road and [illegible]

d. ____________________

TEST



Ob.	A.Z	Mag B	Rod Interval	Vert ∠	Hor Dist
- B	88° 30'	N88°30'E	11.20		1120
E	182° 30'	S2° 30'W	7.26		726
- A	268° 30'	S88°30'W	11.10		1110
C	167°-28'	S17°32'E	13.42	+3°10'	1037
- B	342° 30'	N17°30'W	13.40	-3 10'	1035
D	258° 13'	S78° 13'W	6.37		637
Barn	303° 15'	N56° 45'W			
- C	78° 14'	N78° 14'E	6.35		635
E	298°-00'	N62°00'W	7.17	-4°-50'	713
Barn	24° 00'	N 24° 00'E			
- D	118°-00'	S62° 00'E	7.15	+4°-50'	711
A	2°-30'	N 2°30'E	7.30		730
[illegible]	175°- 13'	S 4° 47'E	4.10		410

Check Angle

A	94° 0'
B	106°-02'
C	84° 17'
D	14° 14'
E	115° 30'

Sum of Mesured Angles 540° 03'

Sequired Sum of Angles (N-2) 180 = 540°00' Error 3'

Allowable error = 15(5)½ = 15×2 236 = 03 4'

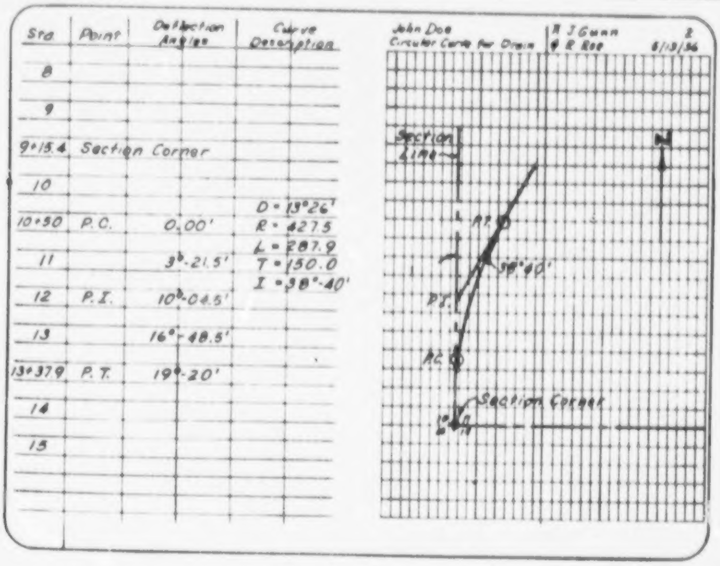
D Warren
Stad a Traverse

R J Gunn
Φ R Roe

2
10/22/86

Tr's = / Dont include in recorded distances
R pt A oriented 0° on Mag N.

e. ______________________________



Sta	Point	Deflection Angles	Curve Description
8			
9			
9+15.4	Section Corner		
10			
10+50	P.C.	0.00'	D = 13°26' R = 427.5
11		3°-21.5'	L = 287.9 T = 150.0
12	P.I.	10°-04.5'	I = 38°-40'
13		16°-48.5'	
13+37.9	P.T.	19°-20'	
14			
15			

John Doe
Circular Curve for Drain

R J Gunn
Φ R Roe

2
6/13/86

Section Line
N
P.T.
38°40'
P.I.
P.C.
Section Corner

f. ______________________________

TEST

11. Complete the following statements concerning traverses by circling the correct words.

    a. Traverses consist of a series of lines known as (**courses, bearings**).

    b. The points where the courses intersect are known as traverse (**bench marks, stations**).

    c. The lengths of the courses are referred to as horizontal (**directions, distances**).

    d. Horizontal (**directions, distances**) are given in terms of azimuth or bearings.

    e. A (**connecting, loop**) traverse closes on itself.

12. Distinguish between a bearing and an azimuth by placing an "A" next to the descriptions of an azimuth or a "B" next to the bearing descriptions.

    ______a. Is an acute horizontal angle which a line makes with the meridian of reference

    ______b. Is measured clockwise or counterclockwise

    ______c. Is measured clockwise only

    ______d. Ranges from 0 to 360°

    ______e. Ranges from 0 to 90°, never greater than 90°

    ______f. Requires two letters (quadrant letters) and a numerical value

    ______g. Require only a numerical value

    ______h. Is the direction a line is deflected from either the north or south meridian

13. State the formulas used to convert bearings to azimuths and azimuths to bearings for the following situations:

    a. For an azimuth from north between 90° and 180°, the bearing is calculated — Bearing = ______________________________

    b. For an azimuth from north between 270° and 360° — Bearing = ____________

    c. For a bearing in the southwest quadrant — Azimuth = ______________

    d. For a bearing in the northeast quadrant — Azimuth = ______________

TEST

14. Select true statements concerning common methods for plotting traverses by placing an "X" next to the true statements.

_____a. To plot traverses by interior angles, all three of the following must be known:

1) Location of starting point and its relationship to at least one other traverse course.
2) The distances of the traverse courses.
3) The interior angle for each traverse station.

_____b. Plotting traverses by distances and bearings is the most complicated method.

_____c. Plotting traverses by azimuths requires only the azimuth readings of traverse points.

_____d. Deflection angle indicates the direction change of each traverse course relative to individual traverse stations.

_____e. Latitudes and departures is a common method used only in plotting open traverses.

_____f. Calculations to find latitude and departure of a bearing:

Latitude - D cos B
Departure = D cos B
(D = Distances of course)
(B = Bearing angle)

_____g. Calculations to find latitude and departure of an azimuth (north):

Latitude = D tan A
Departure = D cot A
(D = Distance of course)
(A = Azimuth N)

_____h. Rectangular coordinates are rather inaccurate ways to plot traverses, but they are fast.

_____i. In the rectangular coordinates method of plotting traverses, east is considered positive, and west is considered negative.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.

15. Plot lines and distances using several methods. (Assignment Sheet #1)

16. Convert azimuths to bearings and bearings to azimuths. (Assignment Sheet #2)

TEST

17. Layout a closed traverse. (Assignment Sheet #3)

18. Complete a mathematical closure of a traverse. (Assignment Sheet #4)

19. Reduce four types of field notes. (Assignment Sheet #5)

20. Draw a map using bearings, distances, and coordinates. (Assignment Sheet #6)

INTERPRETATION OF SURVEYOR'S NOTES
UNIT IV

ANSWERS TO TEST

1.	a.	6	g.	1	l.	20	q.	21
	b.	10	h.	15	m.	16	r.	9
	c.	18	i.	8	n.	19	s.	13
	d.	7	j.	5	o.	12	t.	14
	e.	17	k.	2	p.	11	u.	3
	f.	4						

2.	a.	3	e.	2
	b.	1	f.	2
	c.	2	g.	4
	d.	3		

3. a. Deflection angles
   b. Exterior angle
   c. Interior angle
   d. Angle to the left
   e. Angle to the right
   f. Zenith angle
   g. Plus angle
   h. Minus angle
   i. Nadir angle

4.	a.	3	e.	4
	b.	2	f.	6
	c.	8	g.	7
	d.	1	h.	5

5.	a.	3	d.	4
	b.	6	e.	5
	c.	2	f.	1

6. a, c, e

7. a. Permanent
   b. Upper and lower case
   c. Hard
   d. Are not
   e. Diagonal lines are drawn through the page and "VOID" is lettered prominently with the reasons
   f. At the time of the survey
   g. Sketches
   h. "COPY"
   i. On a clean page

8. b, f, g, i

ANSWERS TO TEST

9. a. 3
   b. 4
   c. 1
   d. 2

10. a. Grid survey
    b. Deflection angle traverse
    c. Profile and cross section
    d. Bench level circuit
    e. Stadia traverse
    f. Circular curves

11. a. Courses
    b. Stations
    c. Distances
    d. Directions
    e. Loop

12. a. B
    b. B
    c. A
    d. A
    e. B
    f. B
    g. A
    h. A

13. a. 180° — AzN
    b. 360° — AzN
    c. 180° + Bearing
    d. Bearing (azimuth and bearing are the same)

14. a, d, i

15.-20. Evaluated to the satisfaction of the instructor

LEGAL LAND DESCRIPTIONS
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe land parcels by the U.S. system of rectangular surveys, metes and bounds, and the lot and block method and discuss state plane coordinates. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to legal land descriptions with the correct definitions.
2. Match methods of legal land descriptions with the correct definitions.
3. Complete statements concerning the U.S. public land survey system.
4. Complete statements concerning the subdivision of a section.
5. Complete statements concerning lot and block descriptions.
6. Select true statements concerning metes and bounds descriptions.
7. List the components used to develop a plat.
8. Complete statements concerning state plane coordinates.
9. Match common legal aspects of land acquisition with the correct definitions.
10. Answer questions based on the U.S. public land survey system. (Assignment Sheet #1)

OBJECTIVE SHEET

11. Write and locate descriptions for the subdivision of a section. (Assignment Sheet #2)
12. Write a lot and block description. (Assignment Sheet #3)
13. Identify components used to develop a plat. (Assignment Sheet #4)

LEGAL LAND DESCRIPTIONS
UNIT V

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Visit the local county courthouse and obtain a copy of the plat for the location of the student's home or school.
2. Arrange a field trip with a local surveyor to observe a surveying team in the field.
3. Obtain a copy of the local codes concerning easements, setbacks, and road right-of-ways.
4. Obtain a U.S.G.S. 7.5 minute quadrangle map of your local area and locate by township, range, and section many local landmarks.
5. Provide the students with a copy of the U.S.G.S. 7.5 minute quadrangle map for use in Assignment Sheet #1.
6. Using Unit III, "Symbols and Abbreviations" as a reference, match symbols and abbreviations to terms in this unit.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1 — Principal Meridians and Base Lines
2. TM 2 — U.S. Public Land Survey System
3. TM 3 — Sample Subdivision of a Section
4. TM 4 — Lot and Block Description
5. TM 5 — Typical Metes and Bounds Description
6. TM 6 — Sample Plat

D. Handout #1 — State Plane Coordinate Grid Systems

E. Assignment sheets

1. Assignment Sheet #1 — Answer Questions Based on the U.S. Public Land Survey System
2. Assignment Sheet #2 — Write and Locate Descriptions for the Subdivision of a Section
3. Assignment Sheet #3 — Write a Lot and Block Description
4. Assignment Sheet #4 — Identify Components Used to Develop a Plat

F. Answers to assignment sheets

G. Test

H. Answers to test

REFERENCES USED IN WRITING THIS UNIT

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B. *Glossaries of BLM Surveying and Mapping Terms,* 2nd ed. Bureau of Land Management/U.S. Department of the Interior, 1980.

C. *Definitions of Surveying and Associated Terms.* American Congress on Surveying and Mapping and the American Society of Civil Engineers, 1978.

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E. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

F. Stephens, Wendell. *Civil Engineering Technicians' Ready-Reference Manual.* New York: McGraw-Hill Book Co., 1985.

G. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

H. *Manual of Surveying Instructions.* Technical Bulletin 6. Bureau of Land Management/U.S. Department of the Interior, 1973.

I. Bies, John and Robert Long. *Mapping and Topographic Drafting.* Cincinnati, OH: South-Western Publishing Co., 1983.

J. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

SUGGESTED SUPPLEMENTAL MATERIALS

A. Kavanagh, Barry and S. J. Glenn Bird. *Surveying: Principles and Applications.* Reston, VA: Reston Publishing Co., Inc., 1984.

B. Brinker, Russell and P.R. Wolf. *Elementary Surveying,* 7th ed. New York: Harper & Row, 1984.

C. Davis, R.E., F.S. Foote, and J.H. Kelly. *Surveying,* 5th ed. New York: McGraw-Hill Book Company, 1966.

LEGAL LAND DESCRIPTIONS
UNIT V

INFORMATION SHEET

I. **Terms and definitions**

A. Azimuth — A horizontal direction measured in degrees from 0 to 360, usually measured from the north

B. Base line — A principal parallel line that runs straight east and west that is used in establishing the public land survey system; is run astronomically by surveyors

C. Bearing — The direction of a line with respect to the quadrants of a compass starting from north or south

D. Bench mark — A relatively permanent material bearing a mark of elevation whose elevation is above or below the adopted datum

E. Bounds — Monuments which define the boundary or limit of property

F. Central meridian — The line of longitude at the center of a projection

G. Chain — A measurement tool composed of links, originally 66 feet in length

H. Coordinates — A set of numbers used in specifying the location of a point

I. Course — In surveying, the direction of a line with reference to a meridian

J. Datum — Any numerical or geometrical quantity or set of such quantities which may serve as a reference or base for other quantities. In ordinary survey usage is a defined reference for survey measurements

K. Deed — Legal document which specifies the ownership of the land

L. Easement — An interest or right in land owned by another that entitles its holder to a specific limited use

M. Elevation — Vertical distance from a datum (generally mean sea level) to a point or object on the earth's surface

N. Geodetic survey — A survey of large areas of land in which corrections are made for the curvature of the earth's surface; the process of triangulation is used

O. Land survey — A survey that locates property corners and boundary lines; usually closed with a traverse

P. Latitude — Arc distance measured in degrees north and south of the equator

INFORMATION SHEET

Q. Legal description — A written statement recognized by law as a definite location of a tract of land by reference to a survey, recorded map, or adjoining property

R. Longitude — Arc distance measured in degrees east and west from the prime meridian

S. Lot and block — A method that describes land by referring to a recorded plat, lot numbers, county, and state

T. Magnetic meridian — The direction a free magnet responds to the earth's magnetic pull

U. Meridian — Line of longitude that runs straight north and south; is run astronomically by surveyors

V. Metes — To measure or to assign by measure, as in the measurement of property lines expressed in units of feet, yards, or rods

W. Monument — Permanent object that marks established points

  1. Natural: Created by nature

     Examples: Trees, rivers

  2. Artificial: Created by human beings

     Examples: Wooden stake, stone or other permanent marker properly located and witnessed

X. Plat — A map of a piece of land

Y. Plot plan — Similar to a plat but showing all buildings, roads, and utilities

Z. Point of beginning — Established corner from which measurements are started

AA. Prime meridian — The meridian of longitude 0°; the meridian of Greenwich, England

BB. Principal meridian — A meridian established as a basis for establishing a reference line for the organization of the public land survey system

CC. Public domain (lands) — Any or all of those areas of land ceded to the federal government by the original states and to such other lands as were later acquired by treaty, purchase, or cession and are disposed of only under the authority of Congress

DD. Subdivision (real estate) — An unimproved tract of land surveyed and divided into lots for purposes of sale

INFORMATION SHEET

EE. Subdivision (USPLS) — The subdivision of a township such as into a section, half section, quarter section, quarter-quarter section, or sixteenth section or lotting, section, township, and range numbers and the description of the principal meridian to which referred

FF. Survey subdivision — A type of land survey in which the legal boundaries of an area are located and the area is divided into parcels of lots, streets, right-of-ways, etc.

GG. Traverse — In surveying, a sequence of lengths and directions of lines between points on the earth, obtained by field measurements and used to determine the positions of points through use of trigonometric computation

HH. Triangulation — A method of surveying in which the stations are points on the ground at the vertices of a chain or network of triangles

II. Triangulation station — A marked and/or described point whose position has been determined by triangulation

II. Methods of legal land descriptions

A. U.S. public land survey system — A system inaugurated by the Continental Congress on May 20, 1785, for the survey of the public lands of the United States. Its distinguishing characteristic is that in the main, and in all cases where practical, its units are in rectangular form.

B. Lot and block description — A method of describing land by referring to a recorded plat, the lot number, the county, and state

C. Metes and bounds survey — A survey of an irregularly-shaped tract of land, not conforming to the rectangular system of survey

D. State plane coordinate systems — The systems established by the U.S. Coast and Geodetic Survey, one for each state in the union, used for defining positions of geodetic stations in terms of plane-rectangular (X and Y) coordinates

III. United States public land survey (USPLS) system (Transparencies 1 and 2)

A. Thirty-seven *inital points* have been established which serve as the starting points for subdividing the public lands.

B. *Principal meridians* and *base lines* pass through initial points and make up the framework upon which this system is built. (Transparency 1)

1. There are 35 principal meridians.

    a. A north-south line is designated the principal meridian for a particular state or area.

    b. The principal meridian is marked and monumented, and is fixed by a longitudinal reading (so many degrees, minutes, and seconds west of the Greenwich Meridian).

    c. Some principal meridians are numbered, some are named.

    Examples: 5th principal meridian, Louisiana meridian, Black Hills meridian

INFORMATION SHEET

2. There are 32 base lines.

    a. These are east-west lines run at right angles (90°) to the principal meridian.

    b. Location of each (latitude) is fixed astronomically (so many degrees north of the equatorial line).

C. The first subdivision of public land is into *quadrangles* (tracts) which are approximately 24-mile squares.

D. To compensate for the convergence of the lines due to curvature of the earth,

1. *Correction lines* (also called *standard parallels*) are run parallel to base lines.

2. *Guide meridians* are run parallel to principal meridians.

E. Townships

1. The quadrangles (24-mile squares) are divided into smaller tracts of land called townships.

2. *Township lines* are east-west lines at six-mile intervals parallel to the base line.

3. *Range lines* are north-south lines at six-mile intervals parallel to the principal meridian.

4. In order to locate a township, two numbers are assigned — a township number and a range number.

    Example: T2S, R4E; T6N, R2W

F. Sections (Transparency 3)

1. A Congressional act in 1796 directed each township to be subdivided into 36 sections.

2. Each section measures approximately one square mile (640 acres).

3. Each section corner is to be monumented.

INFORMATION SHEET

4. The sections in each township are numbered consecutively from 1 to 36 beginning with #1 in the northeast corner of the township and #36 in the southeast corner. (Figure 1)

FIGURE 1

N

	6	5	4	3	2	1	
	7	8	9	10	11	12	
W	18	17	16	15	14	13	E
	19	20	21	22	23	24	
	30	29	28	27	26	25	
	31	32	33	34	35	36	

S

G. Fractional sections

1. Are all sections bordering on the north and west sides of the township

   (NOTE: Each township does not form a perfect square due to the convergence of meridians and other causes.)

2. Are expected in counties bordering oceans, lakes, and streams

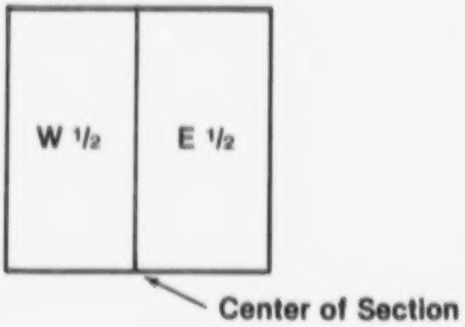
3. Should be divided into equal fractional parts (if possible) with the remaining portions divided into Government lots

   Example: "Government Lot 1 in the N.W. quarter of fractional section _____, township _____ north, range _____ east

IV. **Subdivision of a section** (Transparency 3)

A. In 1800 Congress directed that a section could be subdivided in east and west halves (320 acres each). (Figure 2)

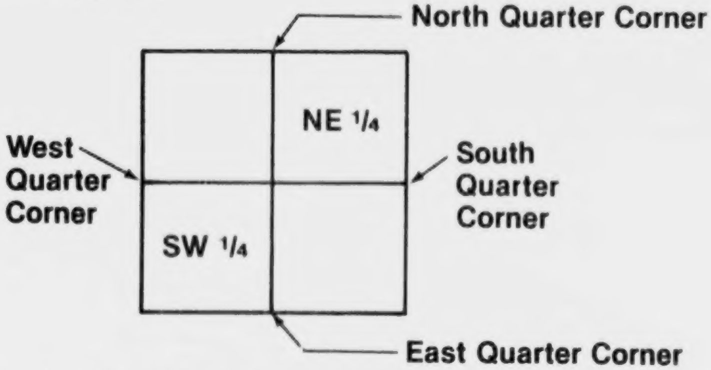
FIGURE 2



INFORMATION SHEET

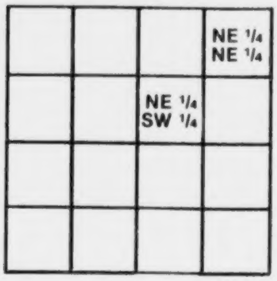
B. In 1805 Congress directed further subdivision into quarter sections and the monumenting of all quarter section corners. (Figure 3)

FIGURE 3


North Quarter Corner
NE ¼
West Quarter Corner
South Quarter Corner
SW ¼
East Quarter Corner

C. At later dates Congress directed further subdivision of the section. The quarter-quarter section of 40 acres is the smallest statutory division of regular sections. (Figure 4)

FIGURE 4


NE ¼ NE ¼
NE ¼ SW ¼

D. Legal descriptions of land which follow the regular subdivision of a regular section must include the section, township, and range.

E. A helpful tip in reading a legal description of a section to locate a tract of land is to read it backwards.

Example Written: N ½, NW ¼, SW ¼, SEC 6, T 55 N, R 69 W

Reads: R 69 W, T 55 N, SECT 6, SW ¼, NW ¼, N ½

F. A complete description always begins with the smallest division and progresses to the largest.

INFORMATION SHEET

V. **Lot and block descriptions** (Transparency 4)

(NOTE: Under the public land survey system, 40 acres is the smallest subdivision of land. To further split up land into smaller parcels or lots is called the subdivision of land [subdivision plat]. This utilizes lot and block descriptions of land.)

- A. Subdivision plat contains
    1. All boundary lines
    2. Necessary monuments
    3. Lines dividing into blocks, lots, and streets
    4. Numbering of lots and blocks
    5. Dimensions of each lot
- B. Exact boundaries of the subdivision may be described by the public land sectional system or metes and bounds.
- C. Lot and blocks describe small units of property in a subdivision.
- D. A legal lot and block must be filed with the county as part of a plat.
- E. Each block is numbered consecutively.
- F. Each lot carries a number shown in consecutive order within the block.
- G. A plat is captioned with the legal description.

    Example: Typical lot and block description: Lot 9, Block 40, Boulder subdivision, City of Louisville, Boulder County, State of Colorado
- H. Advantage of lot and block description is it shows all lots in relationship to other parcels of land.
- I. Recordation of subdivisions
    1. Deed of conveyance shows only the lot and block numbers, the subdivision name and section, and township and range information
    2. Government survey shows the entire subdivision

VI. **Metes and bounds descriptions** (Transparency 5)

- A. Oldest known manner of describing land
- B. Method employed for demarcation of tracts of land in the original 13 states
- C. Often used to describe irregularly shaped plats

INFORMATION SHEET

D. Description must begin at some known point that can be readily identified.

E. Begins at some point in the boundary of the tract and then recites the courses (directions) and distances from point to point entirely around the tract

F. All bounds are listed in rational order and referenced to a chart by bearing, distance, and monuments.

G. The description must close — The courses and distances of a description must come back to the place of beginning.

H. A plat is drawn from a metes and bounds description.

(NOTE: A complete description of real property may include all three types of descriptions in combination — sectional system, metes and bounds, and/or lot and block description.)

VII. **Components used to develop a plat** (Transparency 6)

A. City name

B. County name

C. State name

D. Lot or parcel number, letter, or name

E. Name or number of the map (file reference number if officially filed and page number)

F. Point of beginning

G. Bearings/azimuth and distances

H. Monuments

I. If part of public lands,

  1. Section number
  2. Township number
  3. Range number
  4. Meridian

J. If part of private land grant, (such as Spanish land grant) reference to its map or book and page number

INFORMATION SHEET

VIII. State plane coordinates

A. Was established in 1933 by the U.S. Coast and Geodetic Survey

B. Uses a rectangular grid designed to fit the curved shape of the earth to a plane surface with as little distortion as possible

C. Is used for defining positions of geodetic stations in terms of plane rectangular (X and Y) coordinates

D. All states have established by law a state plane coordinate system in either the Lambert projection or the transverse Mercator projection with one or more zones. (Handout #1)

E. Lambert and Mercator grid systems each select one true meridian (known as the central meridian).

F. All north-south lines of the grids are drawn parallel to the central meridian.

G. The Lambert projection grid assigns an X value at the central meridian (Y axis) of 2,000,000 ft and a Y value at the X axis of "0" ft.

H. The Mercator projection grid assigns an X value to the central meridian (Y axis) of 500,000 ft and a Y value to the X axis of "0" ft.

I. The transverse Mercator projection was limited to 158 miles (approx.) in the east-west width to minimize distortion.

J. The Lambert projection was limited to 158 miles (approx.) in the north-south direction to minimize distortion.

K. Coordinates are based on sea level.

(NOTE: If the local survey is tied into coordinate grid points and is not at sea level, it is necessary to convert the geodetic lengths to ground level distances. Refer to MAVCC's *Basic Surveying Technology,* Unit XII for this formula.)

L. Is used extensively for photogrammetric plotting and electronic surveying

M. Scale error varies from zero up to about one part in 10,000.

N. Use of the state plane coordinate system depends on the availability of a sufficient number of geodetic control monuments to permit the determination of the grid position of points in the survey by plane surveying.

(NOTE: Consult your state codes to determine the extent to which coordinates have been established, the form of designation assigned to them, and their legal connotation.)

INFORMATION SHEET

IX. Legal aspects in land acquisition

A. Adverse possession (also known as Squatter's Rights) — These basic elements must be present for a period of 10-20 years before adverse rights change to legal title.

1. Possession is against wishes of owner and without consent.
2. Possession is open; claimant's intensions are obvious.
3. Actual improvements are present.

   Examples: Fences, construction, farming
4. Possession is exclusive, continuous, and hostile to the rightful owner.

B. Eminent domain — The right of a public authority to take property for public use; requisites for eminent domain include

1. A clear statement of necessity is made.
2. The acquisition is in the public interest.
3. No substitute property will do.
4. Reimbursement will be at fair market value to the owner.

C. Acquiescence of possession

1. Two adjoining property owners agree to a common boundary that does not follow the original surveyed line.
2. Elements for modification of title include
   a. Area in question must be used exclusively and openly by respective property owner.
   b. Period of use must elapse 20 years.
   c. There must be a physical demarcation such as a fence between the two properties.
   d. There must be no disagreement between the two parties as to appropriateness of the line during the statutory period.

D. Riparian rights — Refers to those rights of a property owner of land that borders on a water body

1. The rights include the use of the shore and ownership of land under the water surface and therefore use of the water.

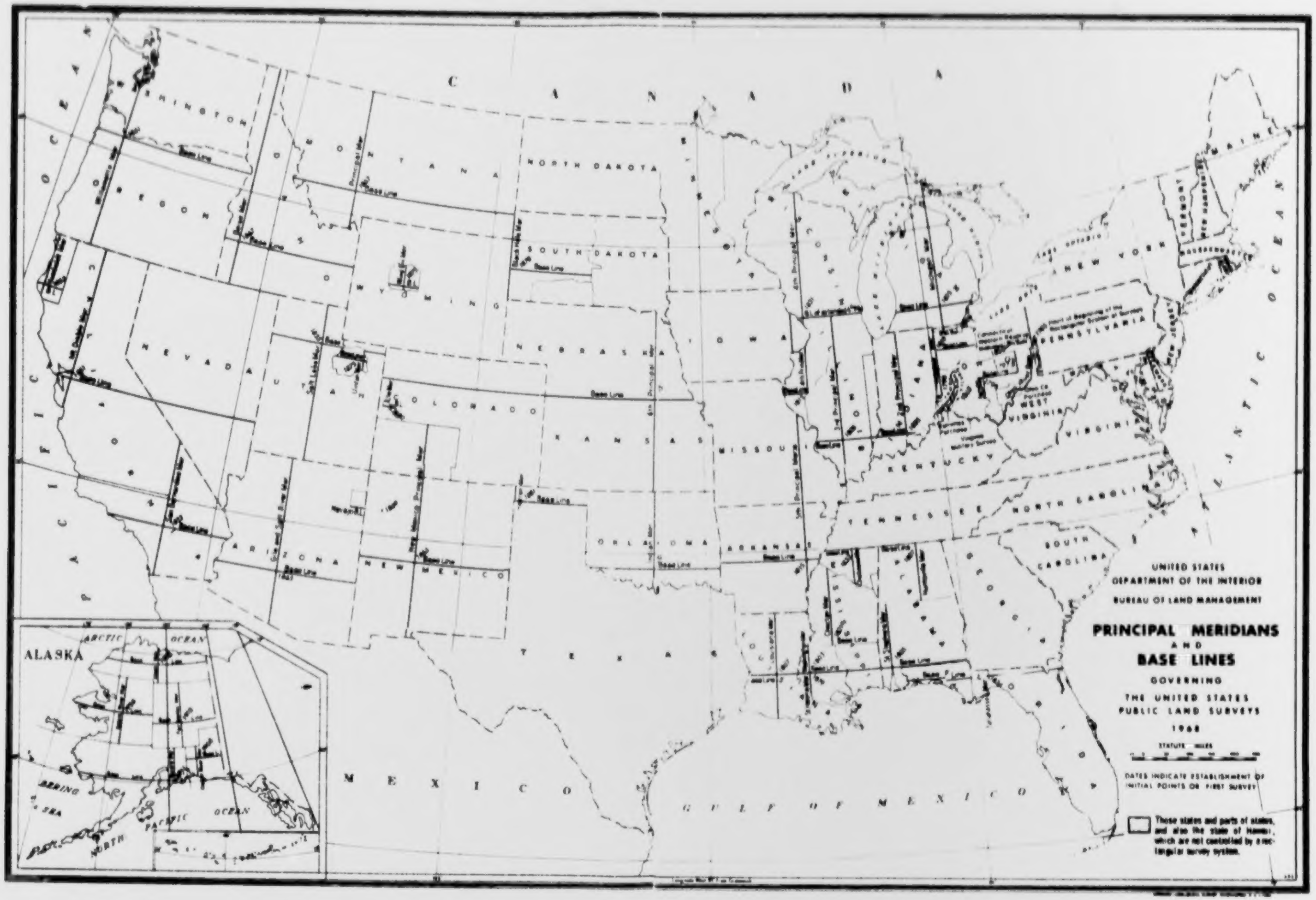
INFORMATION SHEET

2. Ownership may extend only to the high water mark or to the center of a stream or river.

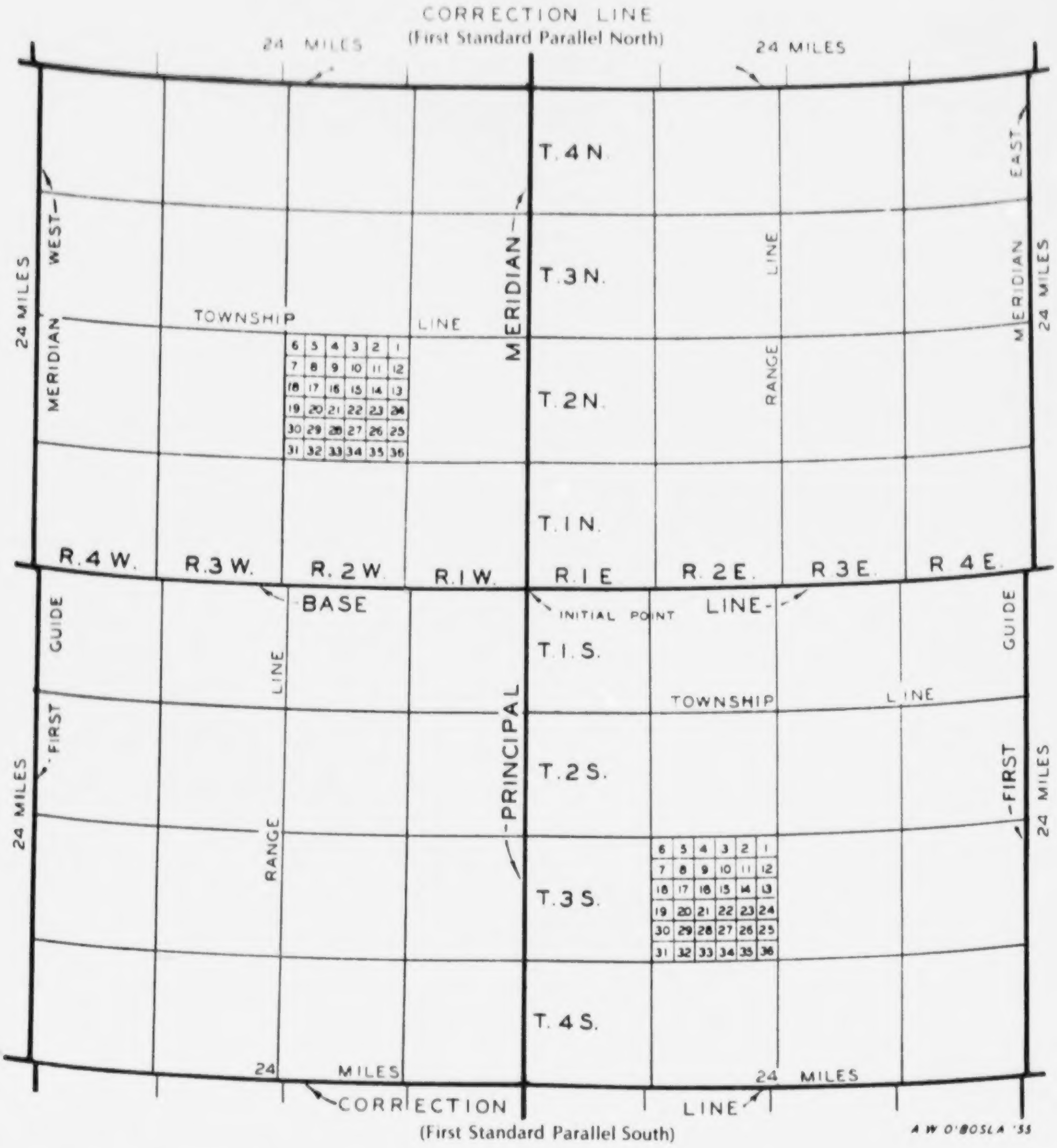
3. Boundaries are both irregular and subject to change.

4. Shoreline road allowances: certain survey systems incorporate a publicly owned strip (usually 1 chain wide) parallel with the shoreline or high water mark.

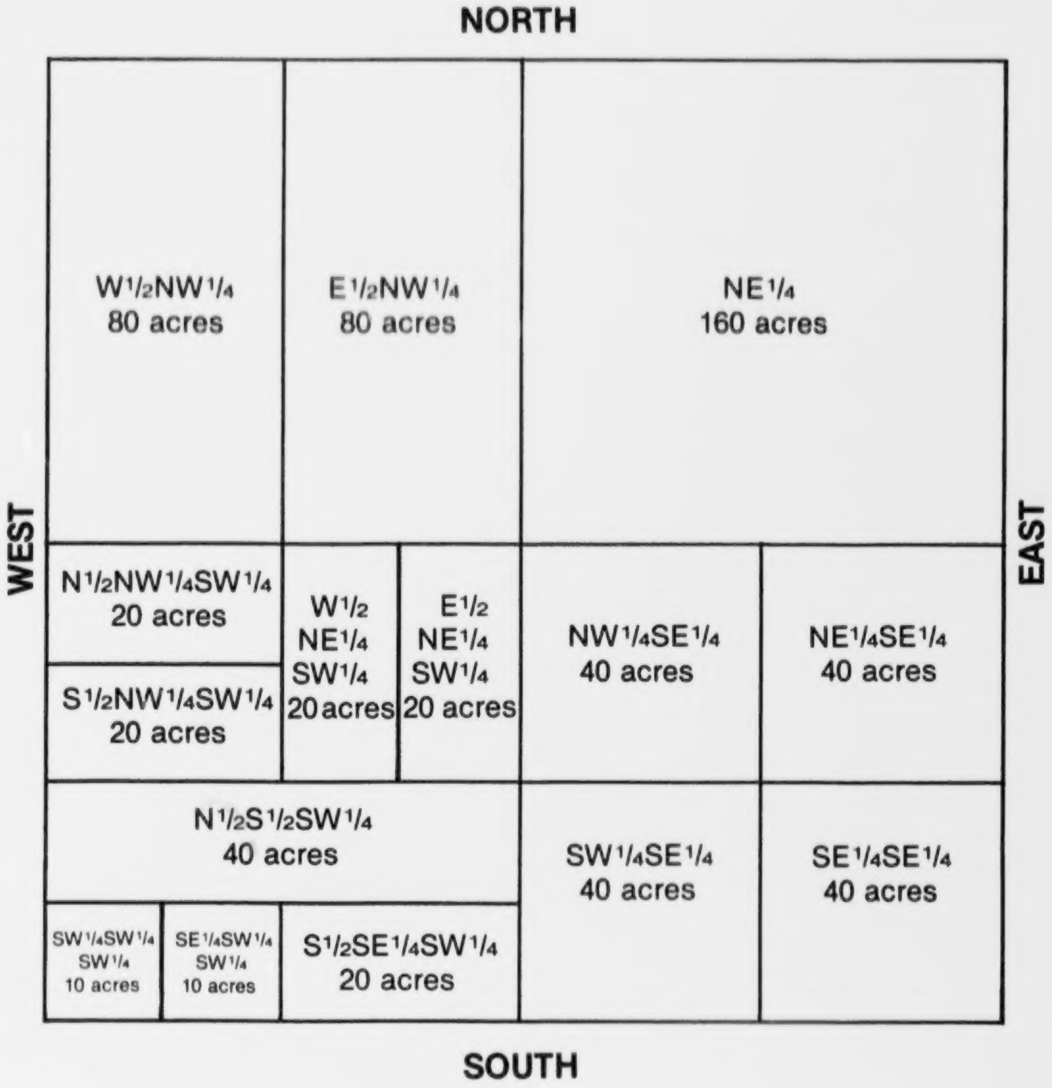
Principal Meridians and Base Lines


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
PRINCIPAL MERIDIANS
AND
BASE LINES
GOVERNING
THE UNITED STATES
PUBLIC LAND SURVEYS
1968
STATUTE MILES
DATES INDICATE ESTABLISHMENT OF INITIAL POINTS OR FIRST SURVEY
Those states and parts of states, and also the state of Hawaii, which are not controlled by a rectangular survey system.
CANADA
MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VERMONT
NEW HAMPSHIRE
NEW JERSEY
Base Line
ALASKA
ARCTIC OCEAN
BERING SEA
NORTH PACIFIC OCEAN

U.S. Public Land Survey System

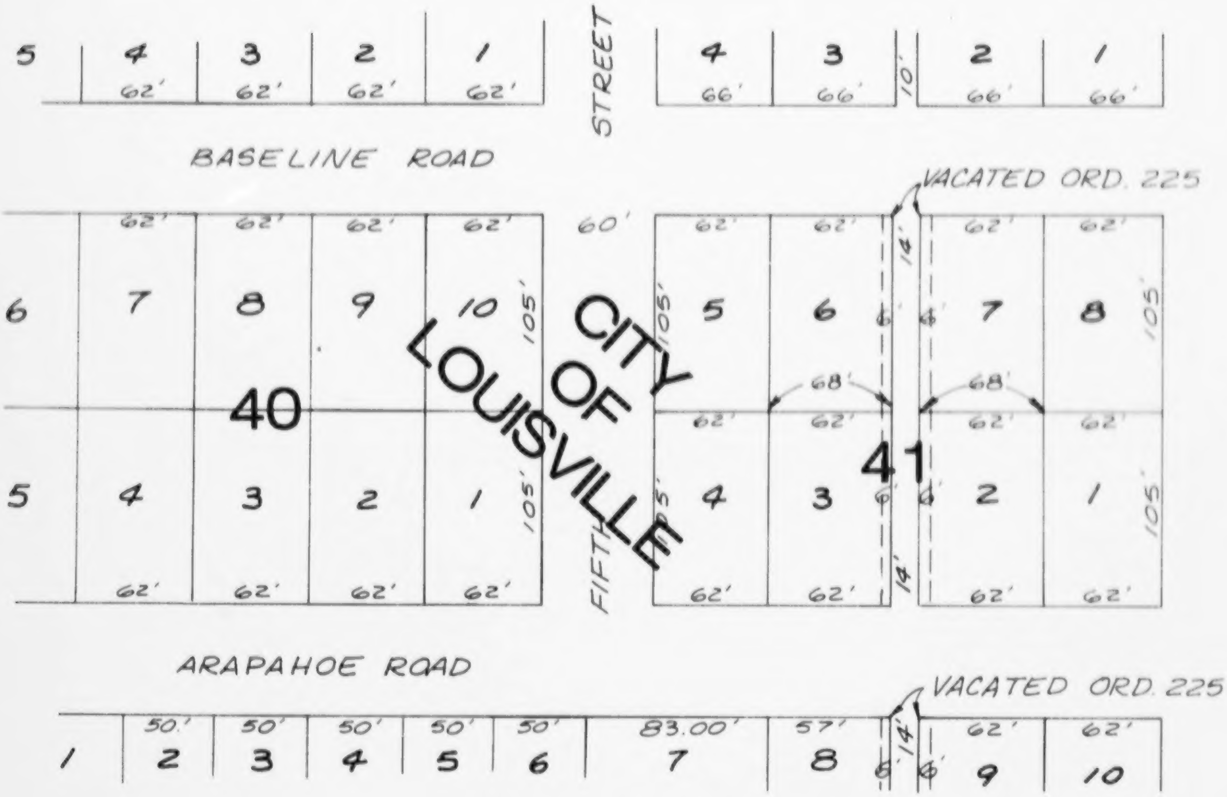

CORRECTION LINE
(First Standard Parallel North)
24 MILES
24 MILES
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
R. 4 W.
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
R. 2 E.
R. 3 E.
R. 4 E.
WEST— MERIDIAN
24 MILES
TOWNSHIP LINE
MERIDIAN—
RANGE LINE
EAST MERIDIAN
24 MILES
6 5 4 3 2 1
7 8 9 10 11 12
18 17 16 15 14 13
19 20 21 22 23 24
30 29 28 27 26 25
31 32 33 34 35 36
BASE LINE
INITIAL POINT
FIRST GUIDE
24 MILES
RANGE LINE
PRINCIPAL
TOWNSHIP LINE
FIRST GUIDE
24 MILES
6 5 4 3 2 1
7 8 9 10 11 12
18 17 16 15 14 13
19 20 21 22 23 24
30 29 28 27 26 25
31 32 33 34 35 36
24 MILES
24 MILES
CORRECTION LINE
(First Standard Parallel South)
A W O'BOSLA '55

Sample Subdivision of a Section

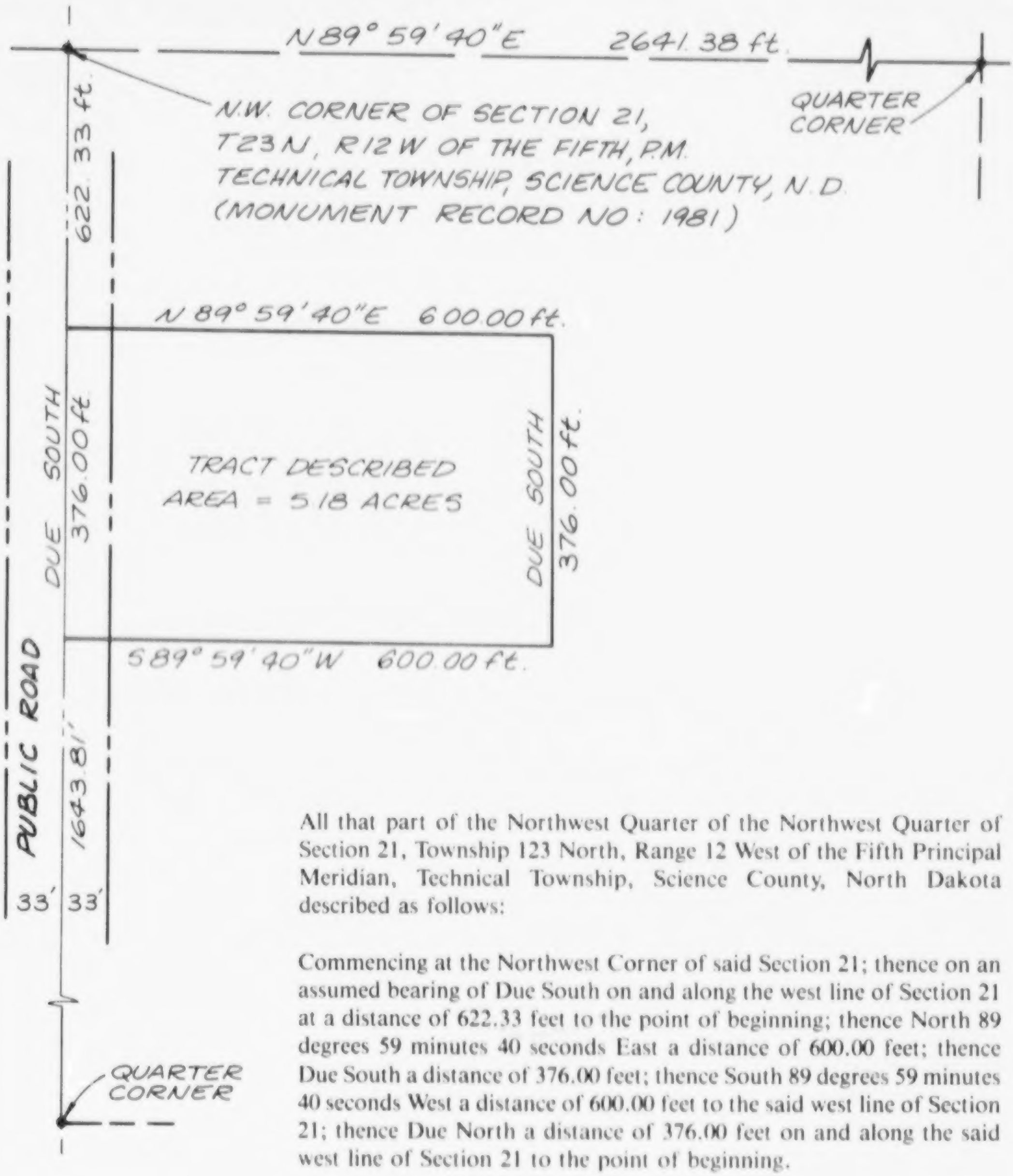

NORTH
W1/2NW1/4 80 acres
E1/2NW1/4 80 acres
NE1/4 160 acres
WEST
N1/2NW1/4SW1/4 20 acres
S1/2NW1/4SW1/4 20 acres
W1/2 NE1/4 SW1/4 20 acres
E1/2 NE1/4 SW1/4 20 acres
NW1/4SE1/4 40 acres
NE1/4SE1/4 40 acres
EAST
N1/2S1/2SW1/4 40 acres
SW1/4SE1/4 40 acres
SE1/4SE1/4 40 acres
SW1/4SW1/4 SW1/4 10 acres
SE1/4SW1/4 SW1/4 10 acres
S1/2SE1/4SW1/4 20 acres
SOUTH

Lot and Block Description

LOT 8, BLOCK 40, BOULDER SUBDIVISION, CITY OF LOUISVILLE, BOULDER COUNTY STATE OF COLORADO


STREET
BASELINE ROAD
VACATED ORD. 225
60'
105'
10'
14'
68'
6'
62'
66'
40
41
CITY OF LOUISVILLE
FIFTH
ARAPAHOE ROAD
VACATED ORD. 225
50'
83.00'
57'
1
2
3
4
5
6
7
8
9
10

Typical Metes and Bounds Description

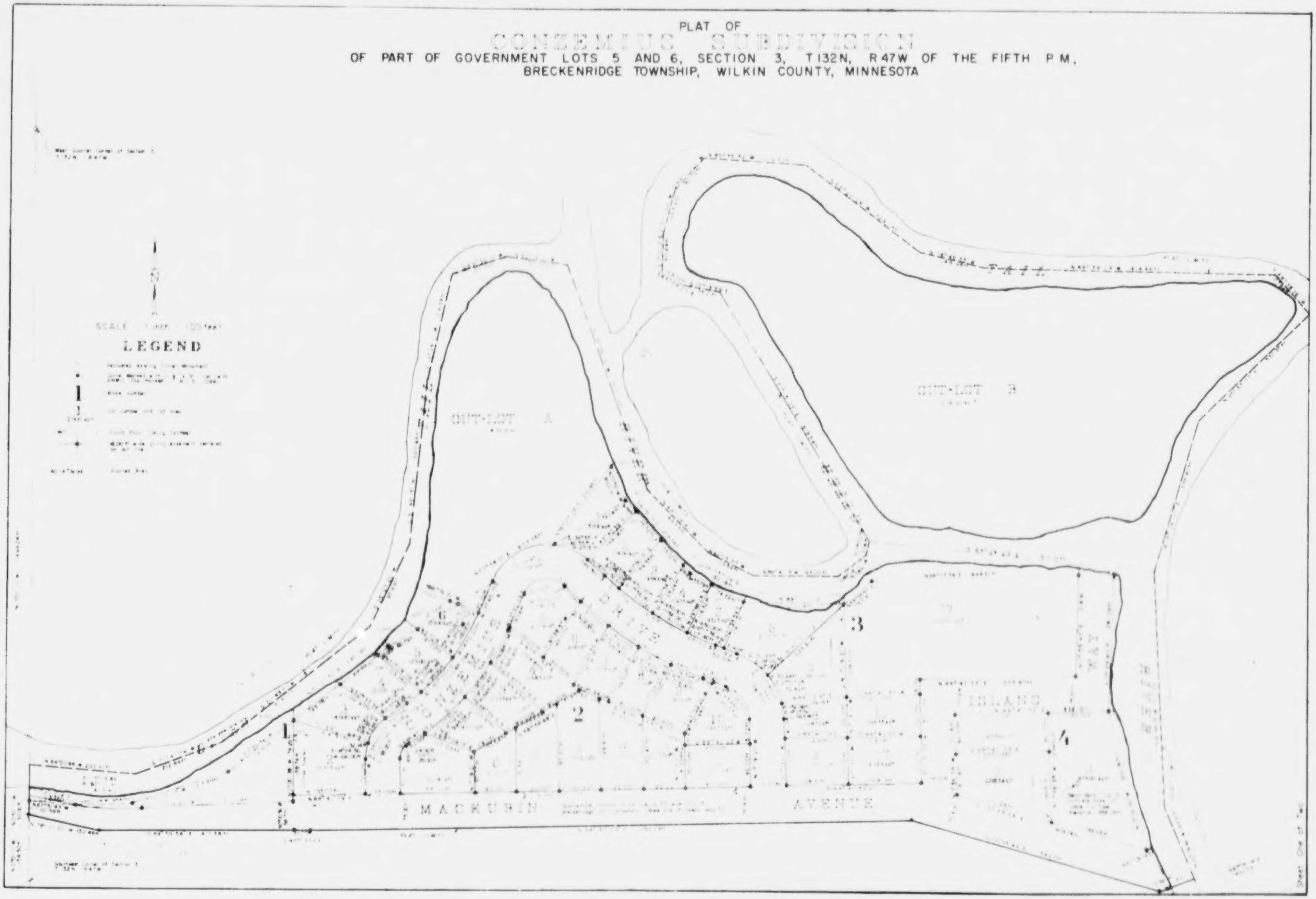

N 89° 59' 40"E 2641.38 ft.
N.W. CORNER OF SECTION 21,
T23N, R12W OF THE FIFTH, P.M.
TECHNICAL TOWNSHIP, SCIENCE COUNTY, N.D.
(MONUMENT RECORD NO: 1981)
QUARTER CORNER
622.33 ft.
N 89° 59' 40"E 600.00 ft.
DUE SOUTH 376.00 ft.
TRACT DESCRIBED
AREA = 5.18 ACRES
DUE SOUTH 376.00 ft.
S 89° 59' 40"W 600.00 ft.
PUBLIC ROAD
1643.81'
33'
33'
QUARTER CORNER

All that part of the Northwest Quarter of the Northwest Quarter of Section 21, Township 123 North, Range 12 West of the Fifth Principal Meridian, Technical Township, Science County, North Dakota described as follows:

Commencing at the Northwest Corner of said Section 21; thence on an assumed bearing of Due South on and along the west line of Section 21 at a distance of 622.33 feet to the point of beginning; thence North 89 degrees 59 minutes 40 seconds East a distance of 600.00 feet; thence Due South a distance of 376.00 feet; thence South 89 degrees 59 minutes 40 seconds West a distance of 600.00 feet to the said west line of Section 21; thence Due North a distance of 376.00 feet on and along the said west line of Section 21 to the point of beginning.

The above described tract contains 5.18 acres more or less and is subject to an existing public road over and across its most westerly 33.00 feet.

Sample Plat


PLAT OF
CONSEMIUS SUBDIVISION
OF PART OF GOVERNMENT LOTS 5 AND 6, SECTION 3, T132N, R47W OF THE FIFTH P.M.,
BRECKENRIDGE TOWNSHIP, WILKIN COUNTY, MINNESOTA
LEGEND
OUT-LOT A
OUT-LOT B
DRIVE
MACKUBIN AVENUE
ISLAND
RIVER
1
2
3
4

LEGAL LAND DESCRIPTIONS
UNIT V

HANDOUT #1 — STATE PLANE COORDINATE GRID SYSTEMS

The mapping grid systems used in the United States vary from state to state, and in some cases, from state zone to state zone. The following is a listing of the states, their zones, and the grid system used per zone. It will be observed that there are two grid systems used in the United States: the Lambert conformal projection, and the transverse Mercator projection.

State and Zone	Mapping Grid System
Alabama	
eastern	transverse Mercator projection
western	transverse Mercator projection
Alaska	
zone 1	oblique transverse Mercator projection
zones 2-9	transverse Mercator projection
zone 10	Lambert conformal projection
Arizona	
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
Arkansas	
northern	Lambert conformal projection
southern	Lambert conformal projection
California	
zones 1-7	Lambert conformal projection
Colorado	
northern	Lambert conformal projection
central	Lambert conformal projection
southern	Lambert conformal projection
Connecticut	Lambert conformal projection
Delaware	transverse Mercator projection
Florida	
eastern	transverse Mercator projection
western	transverse Mercator projection
northern	Lambert conformal projection
Georgia	
eastern	transverse Mercator projection
western	transverse Mercator projection
Hawaii	
zones 1-5	transverse Mercator projection
Idaho	
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
Illinois	
eastern	transverse Mercator projection
western	transverse Mercator projection
Indiana	
eastern	transverse Mercator projection
western	transverse Mercator projection
Iowa	
northern	Lambert conformal projection
southern	Lambert conformal projection

State and Zone	Mapping Grid System
Kansas	
northern	Lambert conformal projection
southern	Lambert conformal projection
Kentucky	
northern	Lambert conformal projection
southern	Lambert conformal projection
Louisiana	
northern	Lambert conformal projection
southern	Lambert conformal projection
Maine	
eastern	transverse Mercator projection
western	transverse Mercator projection
Maryland	Lambert conformal projection
Massachusetts	
mainland	Lambert conformal projection
island	Lambert conformal projection
Michigan	
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
Minnesota	
northern	Lambert conformal projection
central	Lambert conformal projection
southern	Lambert conformal projection
Mississippi	
eastern	transverse Mercator projection
western	transverse Mercator projection
Missouri	
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
Montana	
northern	Lambert conformal projection
central	Lambert conformal projection
southern	Lambert conformal projection
Nebraska	
northern	Lambert conformal projection
southern	Lambert conformal projection
Nevada	
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
New Hampshire	transverse Mercator projection
New Jersey	transverse Mercator projection

HANDOUT #1

State and Zone	Mapping Grid System
New Mexico	
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
New York	
Long Island	Lambert conformal projection
eastern	transverse Mercator projection
central	transverse Mercator projection
western	transverse Mercator projection
North Carolina	Lambert conformal projection
North Dakota	
northern	Lambert conformal projection
southern	Lambert conformal projection
Ohio	
northern	Lambert conformal projection
southern	Lambert conformal projection
Oklahoma	
northern	Lambert conformal projection
southern	Lambert conformal projection
Oregon	
northern	Lambert conformal projection
southern	Lambert conformal projection
Pennsylvania	
northern	Lambert conformal projection
southern	Lambert conformal projection
Rhode Island	transverse Mercator projection
South Carolina	
northern	Lambert conformal projection
southern	Lambert conformal projection
South Dakota	
northern	Lambert conformal projection
southern	Lambert conformal projection
Tennessee	Lambert conformal projection
Texas	
northern	Lambert conformal projection
north-central	Lambert conformal projection
central	Lambert conformal projection
south-central	Lambert conformal projection
southern	Lambert conformal projection
Utah	
northern	Lambert conformal projection
central	Lambert conformal projection
southern	Lambert conformal projection
Vermont	transverse Mercator projection
Virginia	
northern	Lambert conformal projection
southern	Lambert conformal projection
Washington	
northern	Lambert conformal projection
southern	Lambert conformal projection
West Virginia	
northern	Lambert conformal projection
southern	Lambert conformal projection
Wisconsin	
northern	Lambert conformal projection
central	Lambert conformal projection
southern	Lambert conformal projection
Wyoming	
zones 1-4	transverse Mercator projection

LEGAL LAND DESCRIPTIONS
UNIT V

ASSIGNMENT SHEET #1 — ANSWER QUESTIONS BASED ON THE U.S. PUBLIC LAND SURVEY SYSTEM

Directions: Using the U.S.G.S. 7.5 minute quadrangle map provided by your instructor, answer the following questions:

Questions

1. The scale of this maps is______________________________
2. The map series is______________________________
3. The contour interval is______________________________
4. Date of issue______________________________
5. Magnetic declination at date of issue______________________________
6. Year(s) of original survey______________________________
7. Year of revised (updated) survey______________________________
8. What would be the next map to the

   south: ____________________ SE: ____________________

   west: ____________________ SW: ____________________

   north: ____________________ NW: ____________________

   east: ____________________ NE: ____________________

9. In parts, what range(s) is covered by the map?______________________________
10. In parts, what township(s) is covered by the map?______________________________
11. Approximately how many square miles are covered by this map?____________________
12. Choose three cultural features (church, water tank, etc.), and give the legal description of each location using township and range.

    a. ____

    b. ____

    c. ____

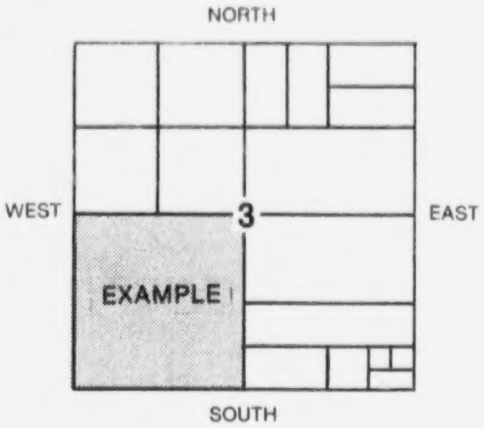
LEGAL LAND DESCRIPTIONS
UNIT V

ASSIGNMENT SHEET #2 — WRITE AND LOCATE DESCRIPTIONS FOR THE SUBDIVISION OF A SECTION

PART I — WRITE DESCRIPTIONS FOR THE SUBDIVISION OF A SECTION

Directions: Write the legal description and acreage of the shaded area of each section given. (Refer to TM 3, Sample Subdivision of a Section.)

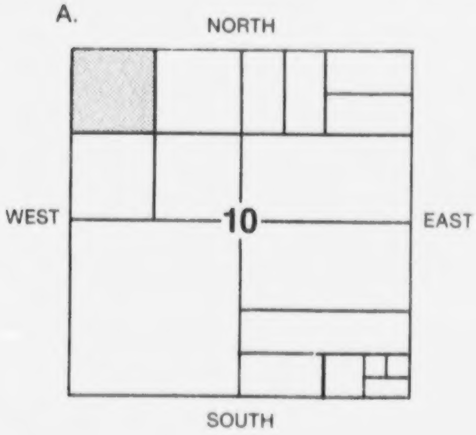
Example:


NORTH
WEST
3
EAST
EXAMPLE
SOUTH

SW ¼, SECTION 3

ACRES: 160

A.

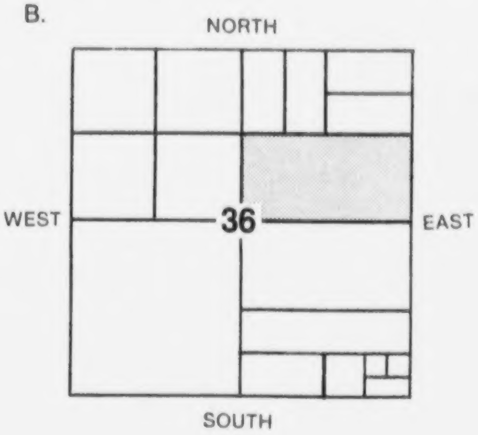

NORTH
WEST
10
EAST
SOUTH

____

____

ACRES: ________________

B.


NORTH
WEST
36
EAST
SOUTH

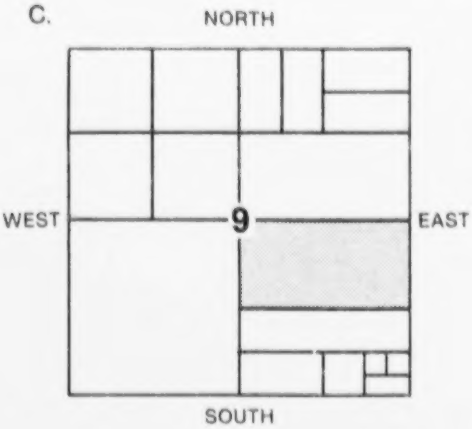
____

____

ACRES: ________________

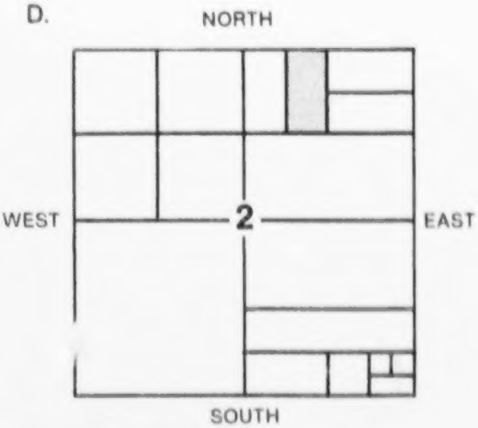
ASSIGNMENT SHEET #2

C.


NORTH
WEST
9
EAST
SOUTH

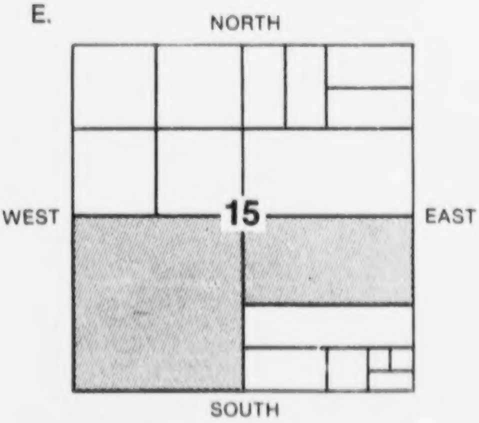
ACRES:

D.


NORTH
WEST
2
EAST
SOUTH

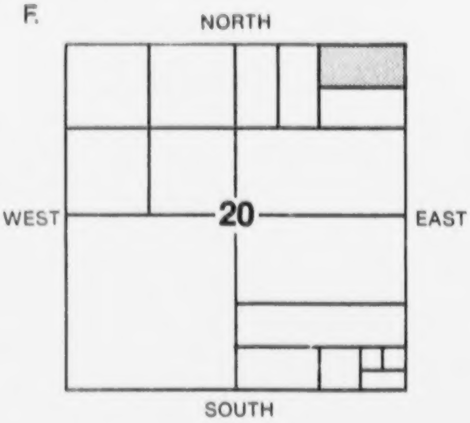
ACRES:

E.


NORTH
WEST
15
EAST
SOUTH

ACRES:

F.


NORTH
WEST
20
EAST
SOUTH

ACRES:

ASSIGNMENT SHEET #2

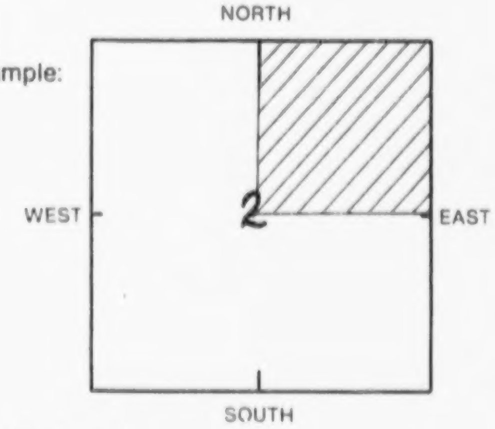
PART II — LOCATE SUBDIVISION OF A SECTION

Directions: The illustrations given are blocks that represent sections and legal descriptions. Using the descriptions given, do the following:

1. Label the section number in the center of section.
2. Subdivide each section according to the legal description. Shade this area in.
3. Give acreage of the shaded area in space provided.

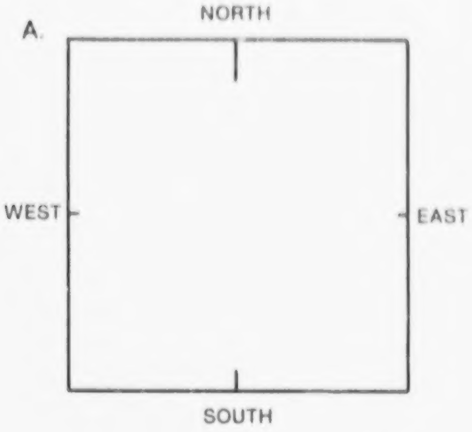
Given Descriptions
Example: NE 1/4, SECT 2
A. SE 1/4, SE 1/4, SECT 10
B. N 1/2, NE 1/4, SECT 31
C. SW 1/4, NW 1/4, SW 1/4, SECT 7
D. SE 1/4 & S 1/2, NE 1/4, SECT 23
E. N 1/2, SECT 5
F. SE 1/4, NE 1/4, SW 1/4, SECT 16

Example:


NORTH
WEST
2
EAST
SOUTH

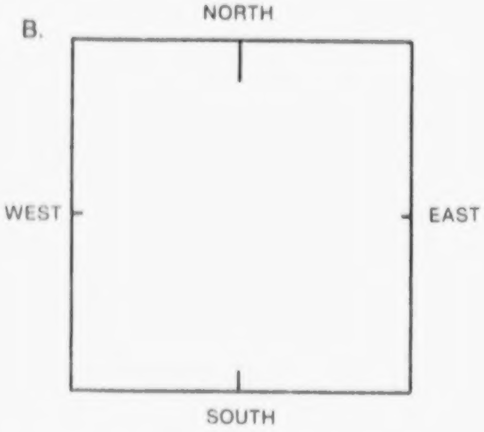
ACRES: 160

A.


NORTH
WEST
EAST
SOUTH

ACRES:________________

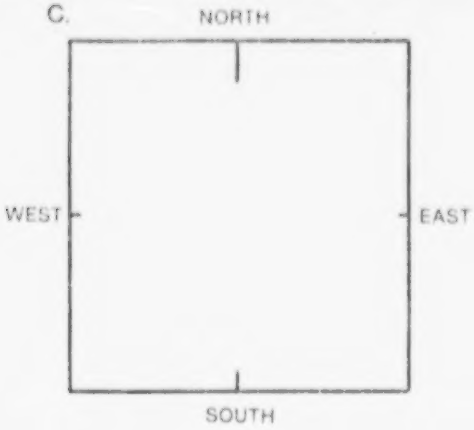
B.


NORTH
WEST
EAST
SOUTH

ACRES:________________

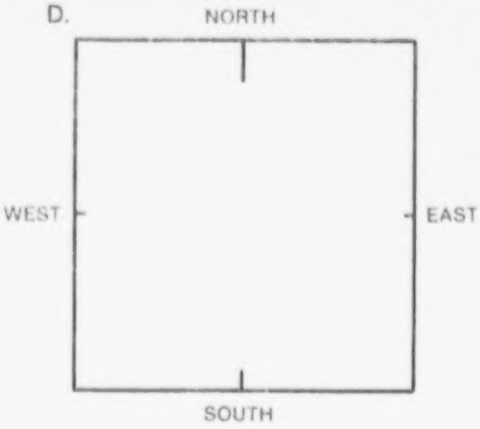
ASSIGNMENT SHEET #2

C.


NORTH
WEST
EAST
SOUTH

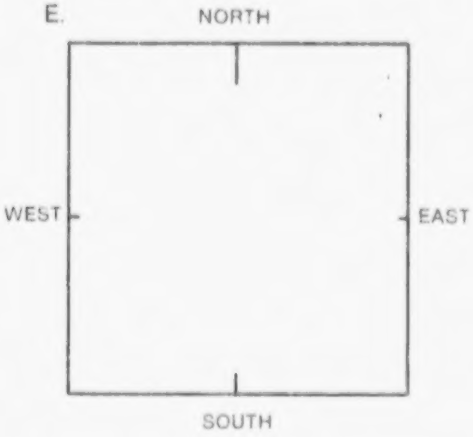
ACRES:____________________

D.


NORTH
WEST
EAST
SOUTH

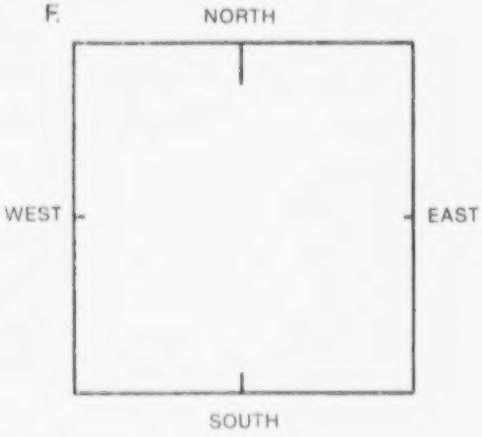
ACRES:____________________

E.


NORTH
WEST
EAST
SOUTH

ACRES:____________________

F.


NORTH
WEST
EAST
SOUTH

ACRES:____________________

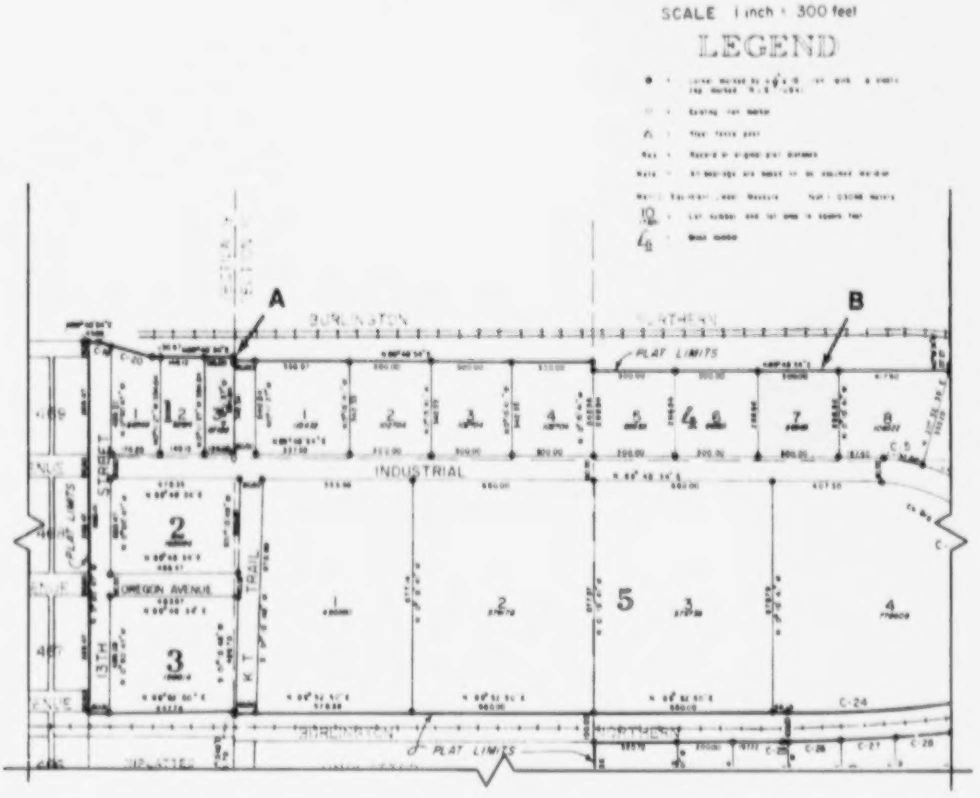
LEGAL LAND DESCRIPTIONS
UNIT V

ASSIGNMENT SHEET #3 — WRITE A LOT AND BLOCK DESCRIPTION

Directions: In the space below write a description for the two lots shaded on this partial subdivision plat.

PLAT OF BRECKENRIDGE INDUSTRIAL PARK

A PART OF SECTION 9, TOWNSHIP 132 NORTH, RANGE 47 WEST WITHIN THE CITY OF BRECKENRIDGE,
AND A PART OF SECTION 10, TOWNSHIP 132 NORTH, RANGE 47 WEST WITHIN BRECKENRIDGE TOWNSHIP,
ALL WITHIN THE FIFTH PRINCIPAL MERIDIAN, WILKIN COUNTY, MINNESOTA


SCALE 1 inch = 300 feet
LEGEND
A
B
BURLINGTON NORTHERN
PLAT LIMITS
INDUSTRIAL
OREGON AVENUE
13TH STREET
K T TRAIL
1
2
3
4
5
C-24
C-5

A. ______________________________

____

B. ______________________________

____

LEGAL LAND DESCRIPTIONS
UNIT V

ASSIGNMENT SHEET #4 — IDENTIFY COMPONENTS USED TO DEVELOP A PLAT

Directions: Answer the following questions referring to Transparency 6 for the answers about the Plat of Conzemius Subdivision.

1. Conzemius Subdivision is in what county? ____________________
2. This is a county in the state of ____________________.
3. Give the name of the township. ____________________
4. What river appears in the plat? ____________________
5. What are the township and range numbers of the west quarter corner of section 3?

   ____
6. What is the elevation of the bench mark on top of the base of the cable T.V. tower?

   ____
7. How wide is the existing utility easement? ____________________
8. What section is this plat in? ____________________
9. How many blocks are listed on the map? ____________________
10. How wide is the drainage easement? ____________________
11. How many acres are in the platted area? ____________________
12. How many square feet are in Lot 6, Block 3? ____________________
13. What is the bearing and distance of the line that is common to Lot 7 and Lot 8 in Block 3? ____________________
14. What is the scale of the map? ____________________
15. What number sheet is this plat? ____________________
16. Sketch the symbol used to identify a recovered existing corner monument.

    ____
17. How wide are the utility easements centered on the lot lines? ____________________

ASSIGNMENT SHEET #4

18. Give the principal meridian used to develop this plat. ________________

19. What is the right-of-way width of Island Way? ________________

20. What is the book and page number where the existing City of Breckenridge Utility Easement can be found? ________________

21. What quarter section is the Conzemius Subdivision in? ________________

LEGAL LAND DESCRIPTIONS
UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1 — Answers will vary depending on which U.S.G.S. 7.5 minute quadrangle map is used. Evaluate accordingly.

Assignment Sheet #2

PART I

A. NW 1/4, NW 1/4, SECT 10 (40 acres)

B. S 1/2, NE 1/4, SECT 36 (80 acres)

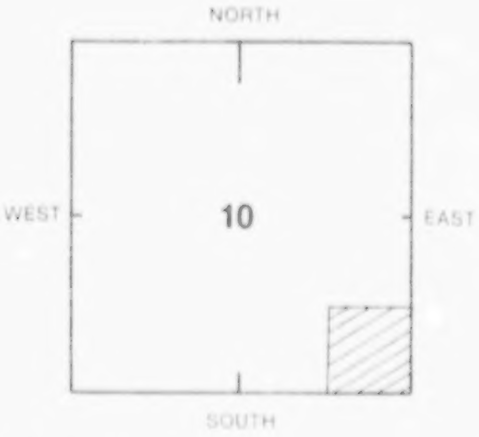
C. N 1/2, S 1/2, SE 1/4, SECT 9 (40 acres)

D. E 1/2, NW 1/4, NE 1/4, SECT 2 (20 acres)

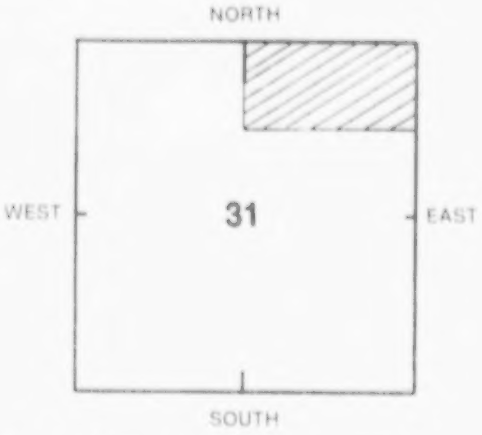
E. SW 1/4 and N 1/2, SE 1/4, SECT 15 (240 acres)

F. N 1/2, NE 1/4, NE 1/4, SECT 20 (20 acres)

PART II

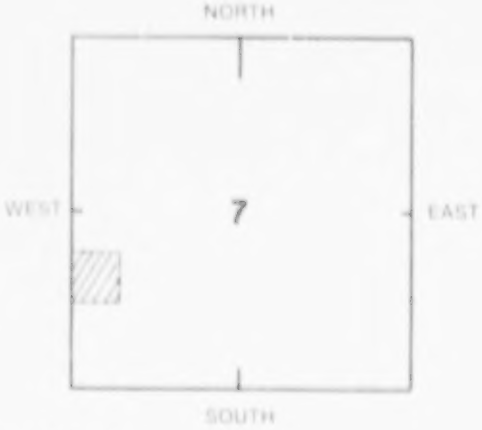

NORTH
WEST
10
EAST
SOUTH

A. 40 acres

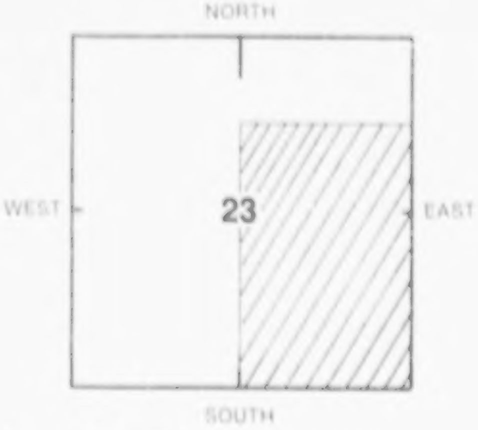

NORTH
WEST
31
EAST
SOUTH

B. 80 acres

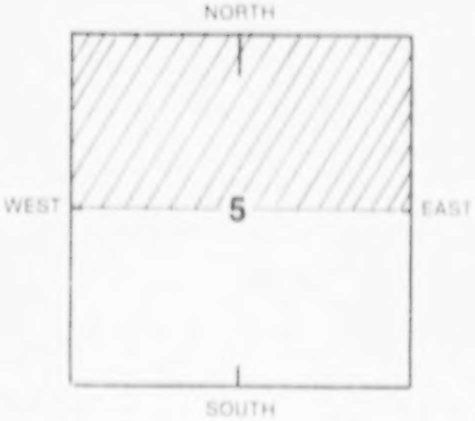
ANSWERS TO ASSIGNMENT SHEETS


NORTH
WEST
7
EAST
SOUTH

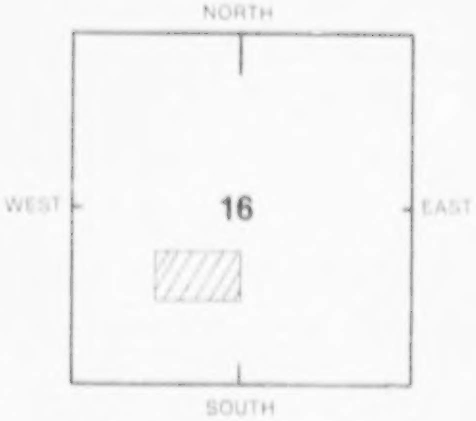
C. 10 acres


NORTH
WEST
23
EAST
SOUTH

D. 240 acres


NORTH
WEST
5
EAST
SOUTH

E. 320 acres


NORTH
WEST
16
EAST
SOUTH

F. 20 acres

Assignment Sheet #3

A. Lot 3, Block 1, Breckenridge Industrial Park, City of Breckenridge, Wilkin County, State of Minnesota

B. Lot 7, Block 4, Breckenridge Industrial Park, City of Breckenridge, Wilkin County, State of Minnesota

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

1. Wilkin County
2. Minnesota
3. Breckenridge
4. Otter Tail River
5. T 132 N, R 47 W
6. 966.19 FT
7. 15 FT
8. Section 3
9. 4
10. 33 FT
11. 40.14 ± acres
12. 21468 SQ FT
13. N 84° 19′ 45″E, 134.19 FT
14. 1″ = 100 FT
15. Sheet 1
16. ○
17. 16 FT
18. 5th P.M.
19. 75.00 FT
20. Book 214, Page 512
21. SW ¼

LEGAL LAND DESCRIPTIONS
UNIT V

NAME ____________________

TEST

1. Match the terms on the right with the correct definitions.

(NOTE: The terms on this page match the definitions on this page only.)

_____a. Arc distance measured in degrees east and west from the prime meridian

_____b. In surveying, the direction of a line with reference to a meridian

_____c. The meridian of longitude 0°; the meridian of Greenwich, England

_____d. An interest or right in land owned by another that entitles its holder to a specific limited use

_____e. A meridian established as a basis for establishing a reference line for the organization of the public land survey system

_____f. Lines of longitude

_____g. The direction of a line with respect to the quadrants of a compass starting from north or south

_____h. A type of land survey in which the legal boundaries of an area are located and the area is divided into parcels of lots, streets, right-of-ways, etc.

_____i. Vertical distance from a datum (generally mean sea level) to a point or object on the earth's surface

_____j. Permanent object that marks established points

_____k. Established corner from which measurements are started

_____l. A method that describes land by referring to a record plat, lot numbers, county, and state

1. Bearing
2. Course
3. Easement
4. Elevation
5. Longitude
6. Lot and block
7. Meridian
8. Monument
9. Point of beginning
10. Prime meridian
11. Principal meridian
12. Survey subdivision

TEST

(NOTE: The terms on this page match the definitions on this page only.)

______m. A survey that locates property corners and boundary lines; usually closed with a traverse

______n. An unimproved tract of land surveyed and divided into lots for purposes of sale

______o. The subdivision of a township such as into a section, half section, quarter section, quarter-quarter section, or sixteenth section or lotting, section, township, and range numbers and the description of the principal meridian to which referred

______p. A principal parallel that runs straight east and west and that is used in establishing the public land survey system of land description

______q. Arc distance measured in degrees north and south of the equator

______r. Legal document which specifies the ownership of the land

______s. A written statement recognized by law as a definite location of a tract of land by reference to a survey, recorded map, or adjoining property

______t. Similar to a plat but showing all buildings, roads, and utilities

______u. A measurement tool composed of links, originally 66 feet in length

______v. A horizontal direction measured in degrees from 0 to 360, usually measured from the north

______w. A survey of large areas of land in which corrections are made for the curvature of the earth's surface

______x. The line of longitude at the center of a projection

______y. The direction a free magnet responds to the earth's magnetic pull

______z. A relatively permanent material bearing a mark of elevation whose elevation is above or below the adopted datum

13. Azimuth
14. Base line
15. Bench mark
16. Central meridian
17. Chain
18. Deed
19. Geodetic survey
20. Land survey
21. Latitude
22. Legal description
23. Magnetic meridian
24. Plot plan
25. Subdivision — real estate
26. Subdivision — USPLS

TEST

(NOTE: The terms on this page match the definitions on this page only.)

______aa. A set of numbers used in specifying the location of a point

______bb. A map of a piece of land

______cc. Bearing and distances cited as courses, measurement of property lines expressed in units of feet, yards, or rods

______dd. Monuments which define the boundary or limit of property

______ee. Any numerical or geometrical quantity or set of such quantities which may serve as a reference or base for other quantities. In ordinary survey usage is a defined reference for survey measurements

______ff. A method of surveying in which the stations are points on the ground at the vertices of a chain or network of triangles

______gg. A marked and/or described point whose position has been determined by triangulation

______hh. Any or all of those areas of land ceded to the federal government by the original states and to such other lands as were later acquired by treaty, purchase, or cession and are disposed of only under the authority of Congress

______ii. In surveying, a sequence of lengths and directions of lines between points on the earth, obtained by field measurements and used to determine the positions of points through use of trigonometric computation

27. Bounds
28. Coordinates
29. Datum
30. Metes
31. Plat
32. Public domain
33. Traverse
34. Triangulation
35. Triangulation station

TEST

2. Match the methods of legal land descriptions on the right with the correct definitions.

_____a. A survey of an irregularly-shaped tract of land, not conforming to the rectangular system of survey

_____b. A system inaugurated by the Continental Congress on May 20, 1785, for the survey of the public lands of the United States. Its distinguishing characteristic is that in the main, and in all cases where practical, its units are in rectangular form

_____c. The systems established by the U.S. Coast and Geodetic Survey, one for each state in the union, used for defining positions of geodetic stations in terms of plane-rectangular (X and Y) coordinates

_____d. A method of describing land by referring to a recorded plat, the lot number, the county, and state

1. U.S. public land survey system
2. Lot and block description
3. Metes and bounds survey
4. State plane coordinates systems

3. Complete statements concerning the United States system of rectangular survey by circling the correct words.

a. There are (**25, 35**) principal meridians.

b. The principal meridian is fixed by a (**longitudinal, latitudinal**) reading.

c. There are (**32, 50**) base lines.

d. (**Range lines, Township lines**) are east-west lines at six mile intervals parallel to the base line.

e. (**Range lines, Township lines**) are north-south lines at six mile intervals parallel to the principal meridian.

f. The Congressional act in 1796 directed each township to be subdivided into (**24, 36**) sections.

g. Each section measures approximately (**1, 24**) square mile(s).

h. The sections in each township are numbered consecutively with #1 in the (**southeast, northeast**) corner.

i. Correction lines serve as new base lines every (**10, 24, 50**) miles.

j. (**Irregular, Fractional**) sections are expected in counties bordering oceans, lakes, and streams.

TEST

4. Complete the following statements concerning the subdivision of a section by filling in the blanks with the correct words.

   a. In 1800 Congress directed that a section could be subdivided in ____________ and ____________ halves (320 acres each).

   b. In 1805 Congress directed further subdivision into ____________ sections and the monumenting of all of those section corners.

   c. At later dates Congress directed further subdivision of the section into ____________ sections.

   d. This subdivision of ____________ acres is the smallest statutory division of regular sections.

   e. Legal descriptions of land which follow the regular subdivision of a regular section must include the section, township, and ____________.

   f. A complete description always begins with the ____________ division.

5. Complete the following statements concerning lot and block descriptions by circling the correct words.

   a. Lot and blocks describe (**subdivision boundaries, small units of property in a subdivision**).

   b. A legal lot and block must be filed with the (**county, state**) as part of a plat.

   c. Each block is (**numbered, lettered**) consecutively.

   d. Each lot carries a (**number, letter**) shown in consecutive order within the block.

   e. A (**lot, block, plat**) is captioned with the legal description.

   f. Advantage of lot and block description is (**it shows all lots in relationship to other parcels of land, it is useful for irregularly-shaped land**).

6. Select true statements concerning metes and bounds descriptions by placing an "X" in the appropriate blanks.

   _____a. Is the newest manner of describing land

   _____b. Is the method employed for demarcation of tracts of land in the original thirteen states

   _____c. Is often used to describe irregularly-shaped plats

   _____d. Description may begin at any point

   _____e. Begins at some point in the boundary of the tract and then recites the courses (directions) and distances from point to point entirely around the tract

   _____f. All bounds are listed in rational order and referenced to a chart by bearing, distance, and monuments

   _____g. The description need not close

   _____h. A plat cannot be drawn from a metes and bounds description

TEST

7. a. List five components used to develop a plat.

1) ____

2) ____

3) ____

4) ____

5) ____

b. If part of public lands, list two additional components used.

1) ____

2) ____

8. Complete the following statements concerning state plane coordinates by circling the correct words.

a. Was established in (**1933, 1953**) by the U.S. Coast and Geodetic Survey

b. Uses a (**circular, rectangular**) grid designed to fit the curved shape of the earth to a plane surface with as little distortion as possible

c. Is used for defining positions of (**coastal, geodetic**) stations in terms of plane rectangular (X and Y) coordinates

d. (**Many, All**) states have established by law a state plane coordinate system in either the Lambert projection or the transverse Mercator projection with one or more zones.

e. Lambert and Mercator grid systems each select (**one, ten**) true meridian(s).

f. All north-south lines of the grids are drawn (**parallel, perpendicular**) to the central meridian.

g. The (**Lambert, Mercator**) projection grid assigns an X value at the central meridian (Y axis) of 2,000,000 ft and a Y value at the X axis of "0" ft.

h. The (**Lambert, Mercator**) projection grid assigns an X value to the central meridian (Y axis) of 500,000 ft and a Y value to the X axis of "0" ft.

i. The transverse Mercator projection was limited to 158 miles (approx.) in the (**north-south, east-west**) width to minimize distortion.

j. The Lambert projection was limited to 158 miles (approx.) in the (**north-south, east-west**) direction to minimize distortion.

k. Coordinates are based on (**sea level, 100 feet above sea level**).

l. Is used extensively for photogrammetric plotting and (**manual, electronic**) surveying

TEST

9. Match the common legal aspects of land acquisition on the right with the correct definitions.

_____a.
1) Two adjoining property owners agree to a common boundary that does not follow the original surveyed line.
2) Area in question must be used exclusively and openly by respective property owner for at least 20 years.
3) There must be no disagreement between the two parties as to appropriateness of the line during the statutory period.
4) There must be a physical demarcation such as a fence between the two properties.

_____b. The following basic elements must be present for a period of 10-20 years: possession is against wishes of owner and without consent, possession is open, actual improvements are present, and possession must be exclusive, continuous, and hostile to the rightful owner.

_____c. The right of a public authority to take property for public use; requisites include

1) A clear statement of necessity is made.
2) The acquisition is in the public interest.
3) No substitute property will do.
4) Reimbursement will be at fair market value to the owner.

_____d. Refers to those rights of a property owner of land that borders on a water body

1. Adverse possession
2. Eminent domain
3. Acquiescience of possession
4. Riparian rights

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

10. Answer questions based on the U.S. public land survey system. (Assignment Sheet #1)

11. Write and locate descriptions for the subdivision of a section. (Assignment Sheet #2)

12. Write a lot and block description. (Assignment Sheet #3)

13. Identify components used to develop a plat. (Assignment Sheet #4)

LEGAL LAND DESCRIPTIONS
UNIT V

ANSWERS TO TEST

1. a. 5
   b. 2
   c. 10
   d. 3
   e. 11
   f. 7
   g. 1
   h. 12
   i. 4
   j. 8
   k. 9
   l. 6
   m. 20
   n. 25
   o. 26
   p. 14
   q. 21
   r. 18
   s. 22
   t. 24
   u. 17
   v. 13
   w. 19
   x. 16
   y. 23
   z. 15
   aa. 28
   bb. 31
   cc. 30
   dd. 27
   ee. 29
   ff. 34
   gg. 35
   hh. 32
   ii. 33

2. a. 3
   b. 1
   c. 4
   d. 2

3. a. 35
   b. Longitudinal
   c. 32
   d. Township lines
   e. Range lines
   f. 36
   g. One
   h. Northeast
   i. 24
   j. Fractional

4. a. East and west
   b. Quarter
   c. Quarter-quarter
   d. 40
   e. Range
   f. Smallest

5. a. Small units of property in a subdivision
   b. County
   c. Numbered
   d. Number
   e. Plat
   f. It shows all lots in relationship to other parcels of land

6. b,c,e,f

ANSWERS TO TEST

7. a. Any five of the following:
    1) City name
    2) County name
    3) State name
    4) Lot or parcel number, letter, or name
    5) Name or number of the map
    6) Point of beginning
    7) Bearings/azimuth and distances
    8) Monuments

   b. Any two of the following:
    1) Section number
    2) Township number
    3) Range number
    4) Meridian

8. a. 1933
   b. Rectangular
   c. Geodetic
   d. All
   e. One
   f. Parallel
   g. Lambert
   h. Mercator
   i. East-west
   j. North-south
   k. Sea level
   l. Electronic

9. a. 3
   b. 1
   c. 2
   d. 4

10.-13. Evaluated to the satisfaction of the instructor

MAP DRAFTING PROCEDURES
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify drafting media and reprographic materials, ink a completed map, and be able to planimeter a map to determine area. Competencies will be demonstrated by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to mapping drafting procedures with the correct definitions.
2. Match types of drafting media with their characteristics.
3. Select true statements concerning characteristics of scribing.
4. Match types of photographic block-out products with the correct characteristics.
5. List types of lettering used in civil drafting.
6. Complete statements concerning rules for good lettering.
7. Distinguish between the methods of map registration.
8. Match reprographic techniques with the correct uses in civil drafting.
9. List types of pressure-sensitive films.
10. List methods used for coloring maps.
11. Complete statements concerning aerial photography.

OBJECTIVE SHEET

12. List methods of drawing reproduction.
13. Arrange in order the standard sheet format for a set of civil drawings.
14. Label components of a map layout.
15. Arrange in order the steps for drafting a map or drawing.
16. List common mistakes made in map drafting.
17. Distinguish between the types of planimeters.
18. Label the parts of a polar planimeter.
19. Complete a tracing in ink of a mapped area. (Assignment Sheet #1)
20. Apply transfer film and press-on letters. (Assignment Sheet #2)
21. Demonstrate the ability to:
    a. Register a map. (Job Sheet #1)
    b. Use a polar planimeter to determine acreage. (Job Sheet #2)

MAP DRAFTING PROCEDURES
UNIT VI

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Provide students with job sheet.

H. Discuss and demonstrate the procedures outlined in the job sheet.

I. Integrate the following activities throughout the teaching of this unit:

1. Refer to MAVCC's *Basic Drafting, Book II,* Unit VIII, for a review on inking techniques and the use and care of technical pens.
2. Write to vendors for current catalogs for newest applications for transfer letters, films, and symbols.
3. Set up a demonstration for current techniques in reprographics with a local drafting supply store.
4. Acquire sets of working drawings from different firms and compare style and format of the drawings.
5. Write to your state highway department for a set of drawing standards.
6. Visit a local civil engineering firm and observe the drafting methods they use.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

J. Give test.

K. Evaluate test.

L. Reteach if necessary.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

  1. TM 1 — Using Scribe Coat
  2. TM 2 — Letter Orientation
  3. TM 3 — Methods of Map Registration
  4. TM 4 — Taping Tips and Techniques
  5. TM 5 — Applying Pressure-Sensitive Film
  6. TM 6 — Percentages of Enlargement and Reduction
  7. TM 7 — Components of a Map Layout
  8. TM 8 — Sample Title Blocks
  9. TM 9 — Types of Planimeters

D. Handouts

  1. Handout #1 — Evaluation of Drafting Media
  2. Handout #2 — Characteristics of Unsensitized Films
  3. Handout #3 — Characteristics of Sensitized Films

E. Assignment sheets

  1. Assignment Sheet #1 — Complete a Tracing in Ink of a Mapped Area
  2. Assignment Sheet #2 — Apply Transfer Film and Press-On Letters

F. Answers to assignment sheets

G. Job sheets

  1. Job Sheet #1 — Register a Map
  2. Job Sheet #2 — Use a Polar Planimeter to Determine Acreage

H. Test

I. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. Hoelscher, Randolph, Clifford Springer, and Jerry Dobrovolny. *Graphics for Engineers.* New York: John Wiley and Sons, Inc., 1968.

B. Nelson, John A. *Drafting for Trades and Industry: Civil.* Albany, NY: Delmar Publishers, 1979.

C. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

D. Bies, John and Robert Long. *Mapping and Topographic Drafting.* Cincinnati, OH: South-Western Publishing Co., 1983.

E. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

F. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

G. Blanchard, Robert. *Pin Register Graphics.* Palo Alto, CA: Robert Blanchard, 1976.

H. *Keuffel & Esser Catalog 3.* Morristown, NJ: Keuffel & Esser Company, 1985.

I. *Drafting, Graphic Charting, and Digital Plotter Media Catalogue.* Morristown, NJ: Keuffel & Esser Company, 1985.

J. Wirshing, Roy and James Wirshing. *Civil Engineering Drafting.* New York: McGraw-Hill Book Co., 1983.

K. *Chartpak Catalog.* Stamford, CT, 1984.

L. *Drafting Manual.* Denver CO: State of Colorado/Division of Highways, 1980.

MAP DRAFTING PROCEDURES
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Acetate — A clear plastic film which has no drafting surface

B. Burnisher — A tool generally used to rub film, letters, or symbols onto a drawing to assure the adherence to the drafting medium

C. Gloss — A surface that has a bright, polished finish

D. Matte — A slightly rough finish free from shine or highlights

E. Medium (pl. Media) — A material used to carry information; in drafting, includes various papers and films used for written and drafted information

F. Mylar — Brand name of a polyester film used as a base for drawing in the drafting industry

G. Opaque — Not permitting the passage of light

H. Peelable film (strippable or unsensitized) — A thin film with a tacky surface that will adhere to another drawing; used to block out areas on a map or drawing

I. Planimeter — A precision instrument used to measure plane areas of any shape

J. Polyester film — A drawing medium that is matte on one or both sides for a drafting surface; accepts both ink and pencil and comes in various mil thicknesses

K. Reproducible — An original drawing on a translucent material suitable for diazo reproduction

L. Scribing/engraving instruments — Similar to mechanical instruments except that the drawing points are cutters or metal tips

M. Sensitized material — A diazo product used in the reproduction process of maps and topos; either negative or positive images can be placed on this film, with more drafting added later as needed

N. Transfer overlay — A master sheet of letters or symbols that can be easily transferred to a drawing by rubbing the symbol with a blunt instrument (burnisher) onto the proper place on the drawing

O. Translucent — Admitting and diffusing light so that objects beyond cannot be clearly distinguished; partly transparent

INFORMATION SHEET

P. Transparent — Transmitting light without appreciable scattering so that bodies lying beyond are clearly visible

Q. Vellum — A prepared tracing paper that has the quality of strength and transparency to make a good drawing surface; generally used with pencil and ink

II. **Types of drafting media and their characteristics** (Handouts #1 — #3)

(NOTE: The media listed below can be obtained from different vendors in roll stock or pre-cut sheets, plain or printed.)

A. Prepared tracing paper (vellum) — 100% rag translucent paper which accepts pencil and ink

B. Natural tracing paper (flimsy/bumwad/yellow trace) — Used for quick notes or changes over a drawing

C. Tracing and drawing polyester films — May be sensitized for special diazo reproduction process or unsensitized for standard work

1. Are available with single or double matte surfaces which accept ink, pencil, or plastic film lead

2. Are available in different mil thicknesses (.002" to .007")

   (NOTE: The thicker the media, the more dimensionally stable the drawing is.)

3. High translucent film is used for overlay drafting.

4. Clear uncoated polyester film is used for overlay work or protective covers. It accepts tape, but does not accept ink.

D. Gridded media — Film or paper printed with black or blue 90° grids with single or double matte surfaces

E. Scribe coat — An opaque-coated polyester film

F. Peel coat — A peelable film used for color separations and map drafting

III. **Characteristics of scribing** (Transparency 1)

A. Is used for close tolerance work

B. Is usually worked over a light table

C. Lines are created by using a scribing tool to incise the special surface.

D. Corrections are done by using a corrective fluid, crayon/pencil, or tape.

E. Lines are clean, sharp, and of a uniform width.

INFORMATION SHEET

F. Finished drawing is a negative for contact or other reproduction.

G. Produces a dimensionally-stable original.

IV. Types of photographic block-out products

A. Block-out film — A light safe, polyester film coated with a low tack, repositionable adhesive

B. Masking film (cut and strip) — A thin, light safe film coated on a clear dimensionally-stable polyester base sheet available in ruby red or amber; .003 mil or .005 mil thickness

C. Peel coat — Produces a peelable negative after film processing

D. Litho blockout tapes — Available in widths 1/32" to 1"

E. Opaquing pen — Used for small spots for instant opaquing

(NOTE: This is waterproof, but is removable with alcohol.)

V. Types of lettering used in civil drafting

A. Hand lettering in pencil or ink using Gothic or Roman styles

(NOTE: Gothic style lettering is used on engineering maps, and Roman style is primarily used on highly finished maps.)

Examples:

AB	AB
Gothic	Roman

B. Mechanical lettering

Example: Leroy lettering

C. Lettering machines

Examples: Kroy lettering, VariTyper

D. Press-on letters

Examples: Chartpak, Lettraset, Format

INFORMATION SHEET

VI. **Rules for good lettering**

A. Use lettering aids to provide guidelines to obtain uniform height in lettering.

B. Lettering usually varies in size on maps in direct relation to the importance of the item to be lettered.

C. Lettering size should be chosen with the reduction factor for final reproduction considered.

D. Lettering should be placed so it is readable from the bottom and the right-hand side of the drawing. (Transparency 2)

E. Attention to consistency of lettering style and overall spacing is important.

F. Lettering for railroads, roads, and waterways on maps should be parallel and close to the symbol.

VII. **Methods of map registration** (Transparency 3)

A. Pin registration

1. Pin bar — Uses a metal strip with projecting pins and stable polyester film properly punched on one edge at corresponding spaces to provide precise registration

2. Individual pins — Uses separate pins that snap into attached tabs that provide registration to multiple sheets for overlay drafting

B. Register marks — Decals or hand-drawn targets that line up on a base sheet with corresponding marks on the overlay

VIII. **Reprographic techniques used in civil drafting**

A. Inking — Application of ink on a drawing, usually executed on film with technical pens or ruling pens.

(NOTE: There are many types of inks available which are selected for different applications based on their characteristics such as erasability and drying time. Refer to the ink manufacturers' specifications for information on these specific characteristics. Pen sizes range from 6×0 to 14 and are available in steel, jewel, and tungsten tips. Refer to MAVCC's *Basic Drafting, Book II* for a review of inking techniques and the use and care of technical pens.)

B. Taping — Can be used in place of ink lines for faster application or to provide a pattern or color line; reproduces well. (Transparency 4)

(NOTE: Many sizes of tapes are available in black and several colors with either gloss or matte surfaces. Pattern tapes are also useful where repetitive patterns are needed. Individual firms can have custom order tapes to meet their special requirements. Tapes do not have a long shelf life for adhesion to the original.)

INFORMATION SHEET

C. Pressure-sensitive film — A material with an adhesive backing that can be applied to drawings to fill in a section with color, pattern, or applied symbol(s). (Transparency 5)

D. Typesetting — Photographic reproduction of text information at any required point size for paste up on a final map or for manual preparation.

E. Photographic methods — Techniques used during the photographic reproduction of a drawing to change its size or appearance.

   1. Photographic screening

   2. Enlargement and reduction (Transparency 6)

F. Xerographic copying (Xeroxing) — Used for duplication and quick reproductions; enlargements, reductions, and color copies are also possible.

(NOTE: Size is generally limited to 8½ × 11 and 8½ × 14 although other sizes are available at copying centers.)

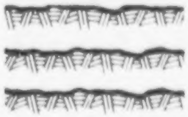
G. Diazo reproduction — Produces 1:1 scale blueline, blackline, or sepia paper or film prints from reproducible originals (vellum or film); relatively inexpensive but quality and shelf life are poor.

(NOTE: Diazo print of overlay drafting is done in a vacuum frame.)

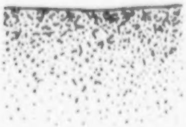
IX. Types of pressure-sensitive films

A. Pattern films

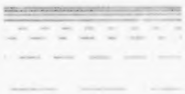
Examples:



Rock



Sand



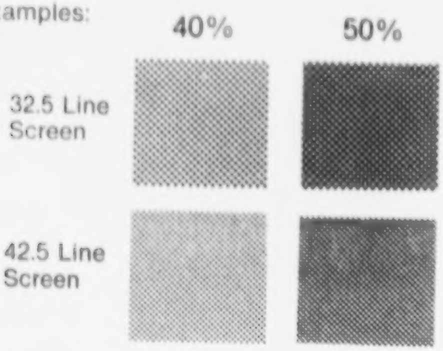
Water

INFORMATION SHEET

B. Shading films (screens)

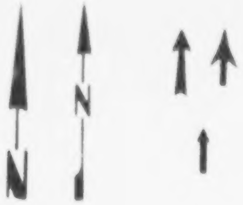
(NOTE: These have many different values with intensities ranging from 10% to 70% and lines from 27.5 to 85. Screens should not be so small that they cover the lettering on the drawing or map.)

Examples:


40%
50%
32.5 Line Screen
42.5 Line Screen

C. Symbol sheets

Examples:

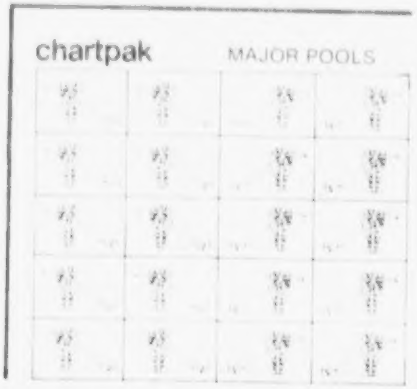


D. Color films

(NOTE: These are available in many colors as transparent or projectable.)

E. Custom transfers — Custom ordered by firms that use certain symbols repetitively

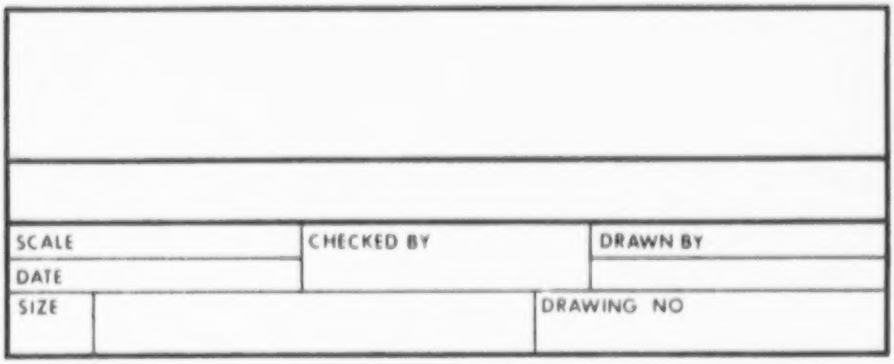
Example:


chartpak
MAJOR POOLS

INFORMATION SHEET

F. Title block transfers (standard or custom)

Examples:



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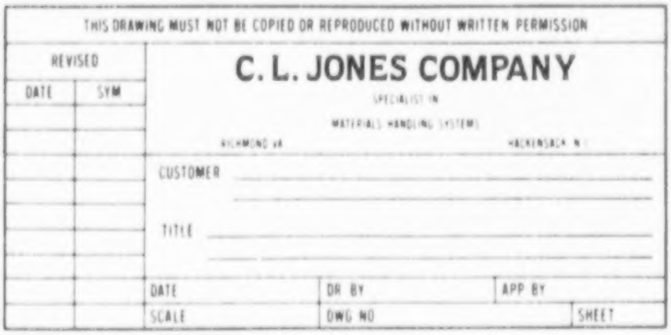


THIS DRAWING MUST NOT BE COPIED OR REPRODUCED WITHOUT WRITTEN PERMISSION

REVISED

DATE SYM

C. L. JONES COMPANY

SPECIALIST IN

MATERIALS HANDLING SYSTEMS

RICHMOND VA HACKENSACK N.J

CUSTOMER

TITLE

DATE DR BY APP BY

SCALE DWG NO SHEET

G. Transfer film

(NOTE: This is a thin, highly transparent film with a sticky back to adhere to originals; has a special surface that can be drafted on with ink, pencil, or typing.)

INFORMATION SHEET

H. Rubber stamp — Used for informal, temporary information

Example:

FIELD INSPECTION

ROADWAY PLANS

Rubber Stamped

X. **Methods used to color maps**

A. Colored pencils

B. Felt tip markers (Magic markers)

C. Color separations: photographic processes in the printing of maps

D. Color transfer films

(NOTE: Colors should be used along with map symbols for identification by individuals who are color blind.)

XI. **Aerial photography**

A. Applications of aerial photography

1. Photo interpretation — The analysis of aerial photographs for the identification and measurement of surface objects and features.
2. Stereo compilation — To extract precisely located feature information from aerial photography.
3. Orthophotography — All information not found on the photo are overprinted onto the photo (then known as a photomap).
4. Analytical aerotriangulation — Producing coordinates of photo control points by mathematical procedures rather than by analog methods.

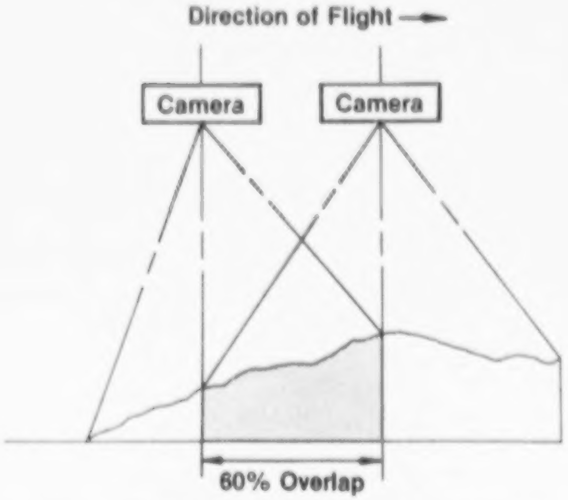
INFORMATION SHEET

B. Aerial photographs with ground control points that are predetermined locations over the area to be photographed.

C. Aerial photographs overlap each other.

   1. 60% along flight lines

   2. 30% overlap between adjacent flights



D. Stereoviewing of aerial photographs — The projection of two or more overlapping images, which creates a 3-dimensional model.

E. Scale of the aerial photograph

   1. Is identified prior to taking photograph.

   2. Factors in scale selection:

      a. Use

      b. Size

      c. Shape

      d. Financial resources

F. Photo mosaic — A series of aerial photographs that are taken along a given flight line combined into one large photograph; constructed by matching images that appear on overlapping photographs.

(NOTE: Because of the distortion found around the edges of a single aerial photo, it is necessary to group many together to obtain a less distorted view of an area of land.)

INFORMATION SHEET

XII. **Methods of drawing reproduction**

A. Diazo print — Blueline or blackline paper or film prints

B. Intermediate (sepia or black) — Film or paper copy that becomes a 2nd original of the copied drawing

C. Xerographic copying (Xeroxing)

D. Photo engraving

E. Photo offset printing

XIII. **Standard sheet format for a set of civil drawings**

A. Cover sheet — key map

B. Area map

C. Plan and profiles

D. Cross sections

E. Construction details

F. Notes

XIV. **Components of a map layout** (Transparency 7)

A. Border

B. Mapped area

C. Legend

D. Meridian arrow

E. Title block

F. Notes

XV. **Steps for drafting a map or drawing**

A. Select sheet medium (film or paper) and size.

B. Lay in the border.

1. Use heavy ink lines (size 4 or 5 pen).

2. Leave a larger border at left of sheet to allow for possible future binding.

INFORMATION SHEET

C. Plot in map area on a layout sheet.

1. Determine necessary space for the plotting and drafting of the map area.
2. Place map area generally to the left of center of the sheet leaving ample room around the mapped area for notes and dimensions.
3. Plot control points and traverse.
4. Plot in topographic information if applicable.
5. Lay in additional features.

   Examples: Cultural and vegetation symbols
6. Lay in the location of labels and dimensions.

D. Place the title block. (Transparency 8)

1. Place title block in the lower right hand corner.

   (NOTE: Never place it within the map area.)
2. Title will include as it applies:
   a. Type of map
   b. Name of property or project
   c. Owner or user
   d. Location or area
   e. Date completed
   f. Scale
   g. Contour interval
   h. Horizontal and vertical datums
   i. Name of surveyor, engineer, or architect and license number where applicable

   (NOTE: Additional data may be required on special purpose maps.)
3. Lettering should be simple to read.
4. Size of lettering should adjust proportionally with the importance of the information in the title block.
5. Symmetry of layout around a centerline is required.

INFORMATION SHEET

E. Locate the meridian arrow.

(NOTE: Refer to Unit III, "Standard Symbols and Abbreviations.")

1. Generally north points to the top of the sheet.

   (NOTE: The meridian arrow should reflect the position of north used in the mapped area.)

2. True, grid, and magnetic north may all be shown.
3. Arrow styles vary.

   (NOTE: Each firm or engineer may have a style preference.)

4. Generally located to the top and right on sheet.
5. Arrow can be traced from a sheet of standards or be a stick-up from a transfer sheet.

F. Place the legend.

1. Locate it where it best balances the sheet.

   (NOTE: If several map areas or items are included on the sheet, locate the legend near the items the legend applies to.)

2. List symbols in one column with feature names in the column next to it.
3. Place the label "legend" centrally over the columns and use a larger letter size.

G. Letter in the notes.

1. Cover special features pertaining to the individual map.
2. Locate in a prominent place, generally to the left or above the title block.
3. May be hand lettered, mechanical lettered (Leroy), or typed on polyester adhesive-backed material.

H. Perform final inking.

1. Determine line weights for final drawing.
2. Determine type of lettering.
3. Determine size of lettering.

INFORMATION SHEET

XVI. **Common mistakes made in map drafting**

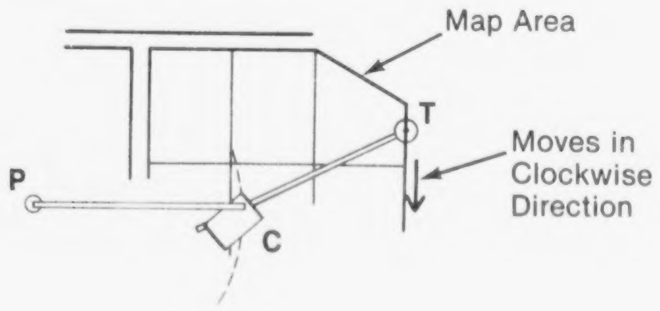
- A. Not checking (scaling distances when plotting by coordinates)
- B. Plotting by protractor
- C. Using a soft pencil or one with a blunt point
- D. Variation in dimensions of map sheet due to temperature and moisture
- E. Selecting an inappropriate scale or contour interval for the map
- F. Improperly orienting topographic notes in field or office
- G. Using wrong edge of engineer's scale
- H. Making the north arrow too large, complex, or black
- I. Omitting the scale or necessary notes
- J. Failing to balance the sheet by making a preliminary sketch
- K. Drafting the map on a poor-quality medium

XVII. **Types of planimeters** (Transparency 9)

- A. Polar planimeter — Has a fixed or adjustable arm.
  1. Fixed arm planimeter — Measures areas in square inches (in^2) or square centimeters (cm^2), then multiplied by a factor.
  2. Adjustable arm planimeter — Can be set to a variety of ratios for direct reading from the dial.
- B. Disc planimeter
  1. Is considered more precise than the polar planimeter.
  2. Is recommended for use on maps or charts that have been reduced to a small scale.
- C. Electronic planimeter
  1. Has a digital readout of the area measured.
  2. Minimizes the possibility of decimal mistakes.
  3. Can be instantly set on zero.

INFORMATION SHEET

XVIII. Parts of a polar planimeter



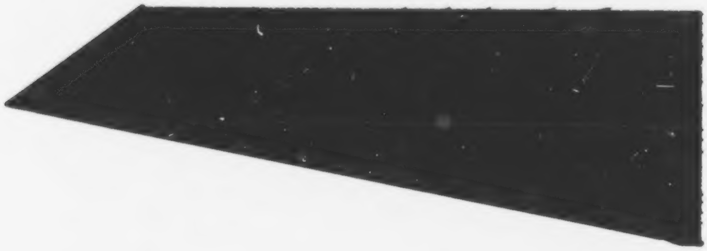
A. Tracer (T) — A metal pointer or dot on a magnifying glass.

B. Pole (P) — A weighted, fixed point used to hold the planimeter in place.

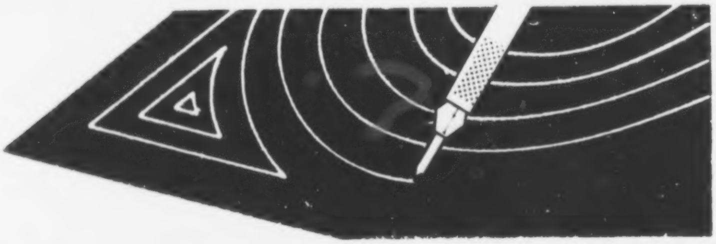
C. Counter box (C)

   1. Has a socket into which pivot (B) and the end of the polar bar (PB) rest.
   2. Allows the two arms to rotate around the pole (P).
   3. Contains a dial that rolls forwards and backwards as the pointer follows the outline.
   4. The dial registers the number of revolutions to the nearest 0.01 revolutions.
   5. The vernier scale registers the nearest 0.001 revolution.

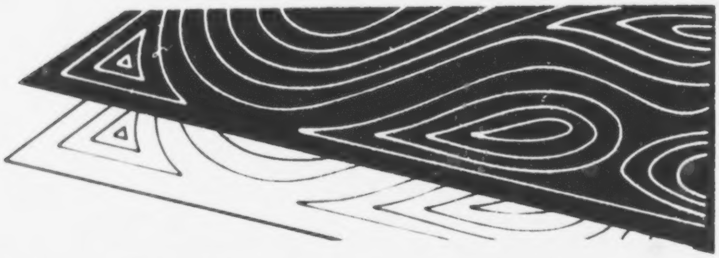
Using Scribe Coat



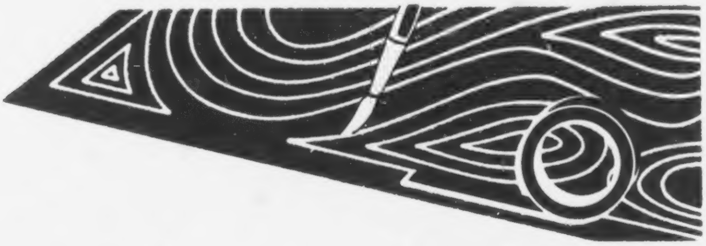
Step 1 — Transfer manuscript to film photographically or lay scribe coat over manuscript on tight table for tracing.



Step 2 — Use scribing tool to engrave desired lines into film.



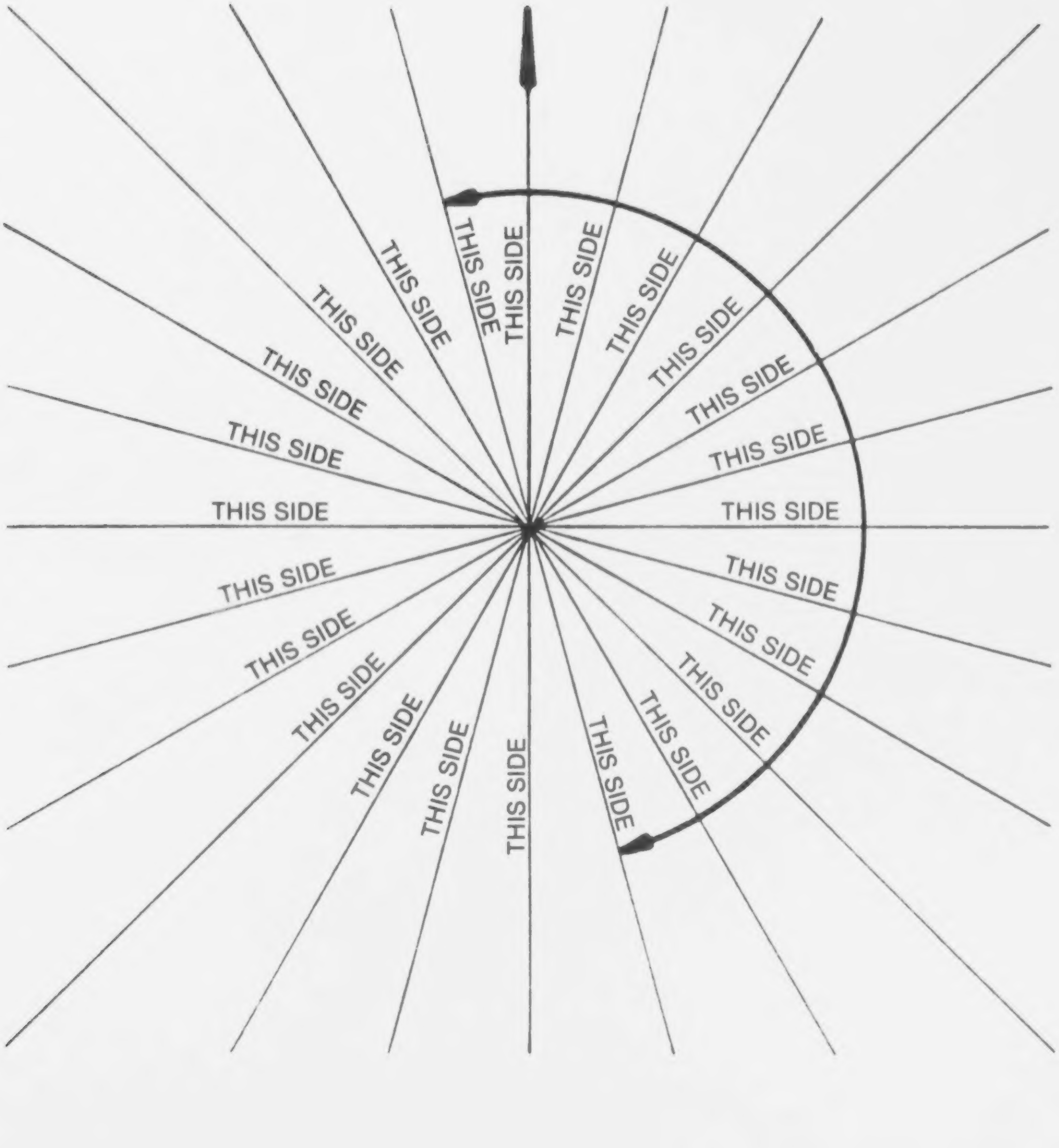
Step 3 — The finished scribed drawing serves as the negative for contact printing and/or other reproduction.



Make corrections by masking scribed areas with retouching fluid, opaquing pen, or opaque masking tape.

Courtesy of Keuffel and Esser Company.

Letter Orientation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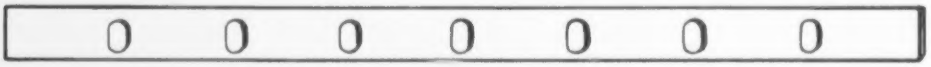
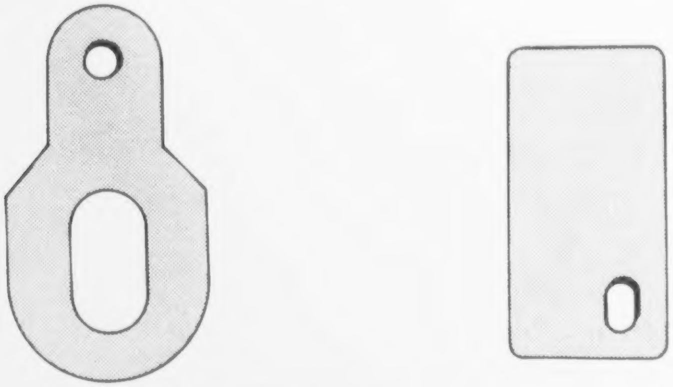
Methods of Map Registration

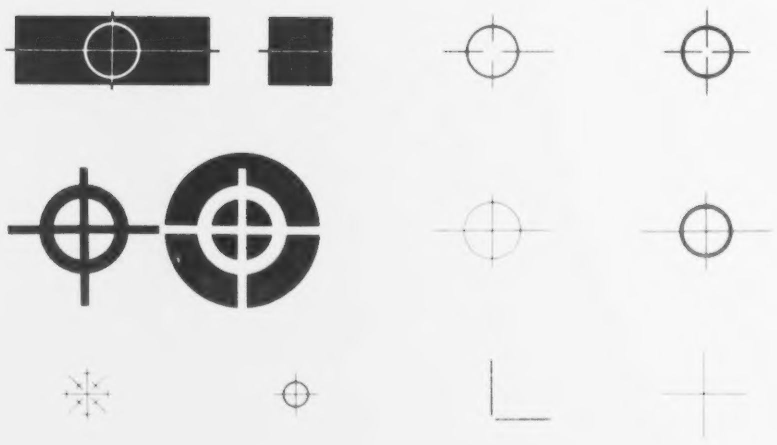


Pin Bar



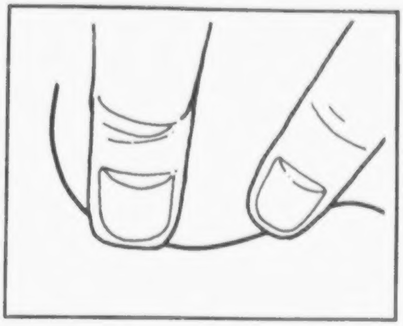
Individual Pins

Examples of Pin Registration



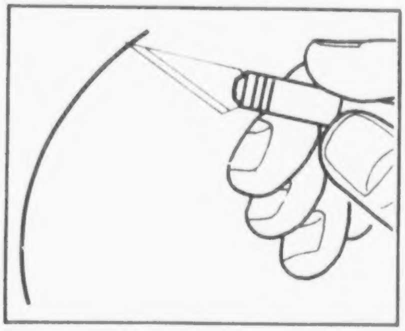
Examples of Register Marks

Taping Tips and Techniques



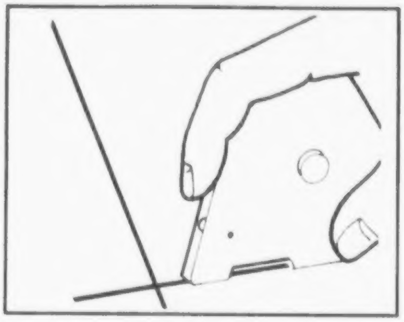
Curve Line Widths

When applying the narrow width tapes (1/64" through 3/32"), hold the tape down with one thumb and curve the tape carefully with your index finger, following your pre-drawn line.



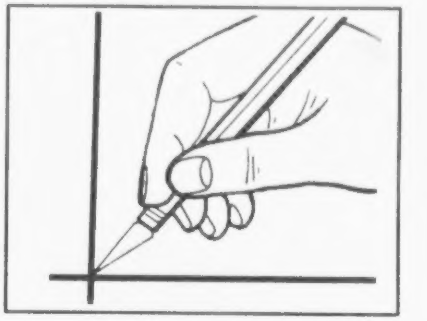
Repositioning

When applying tapes, adhere loosely at first until exact location is determined. Once burnished, it is difficult to reposition tapes without damaging surface of board.



Mitering Corners

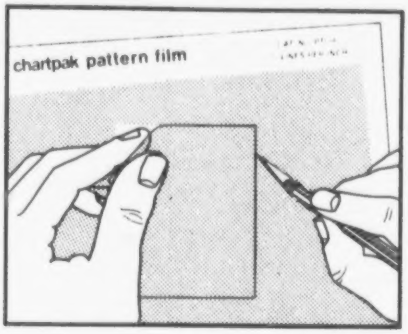
A. To miter a corner that ensures a tight well-fitting joint, overlap tape at corner using tape pen if possible for ease in handling.



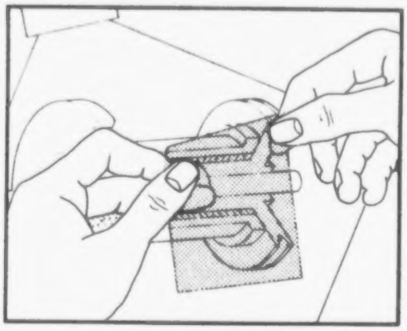
B. Cut off excess tape diagonally from outside to inside corner. Press firmly to cut through both layers of tape. Lift tape with art knife and remove excess. Reposition tape and burnish for a perfect corner.

Courtesy of Keuffel and Esser Company.

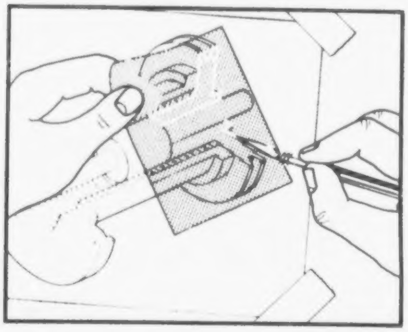
Applying Pressure-Sensitive Film



Step 1 — Cut a section slightly larger than required. Slide point of knife under film and lift off of carrying sheet.



Step 2 — Position and press firmly.



Step 3 — Using a sharp knife, trim and peel off surplus.

Courtesy of Keuffel and Esser Company.

Percentages of Enlargement or Reduction

Scale Change		*Percentage
From	To	Enlargement (E) — Reduction (R)
1" = 20'	1" = 40' 1" = 50' 1" = 100' 1" = 200'	50% R 40% R 20% R 10% R
1" = 40'	1" = 20' 1" = 50' 1" = 100' 1" = 200'	200% E 80% R 40% R 20% R
1" = 50'	1" = 20' 1" = 40' 1" = 100' 1" = 200'	250% E 125% E 50% R 25% R
1" = 100'	1" = 20' 1" = 40' 1" = 50' 1" = 200'	500% E 250% E 200% E 50% R
1" = 200'	1" = 20' 1" = 40' 1" = 50' 1" = 100'	1000% E 500% E 400% E 200% E

* Stated in % of original size

For percentages to enlarge or reduce scales not shown, divide the desired into the existing:

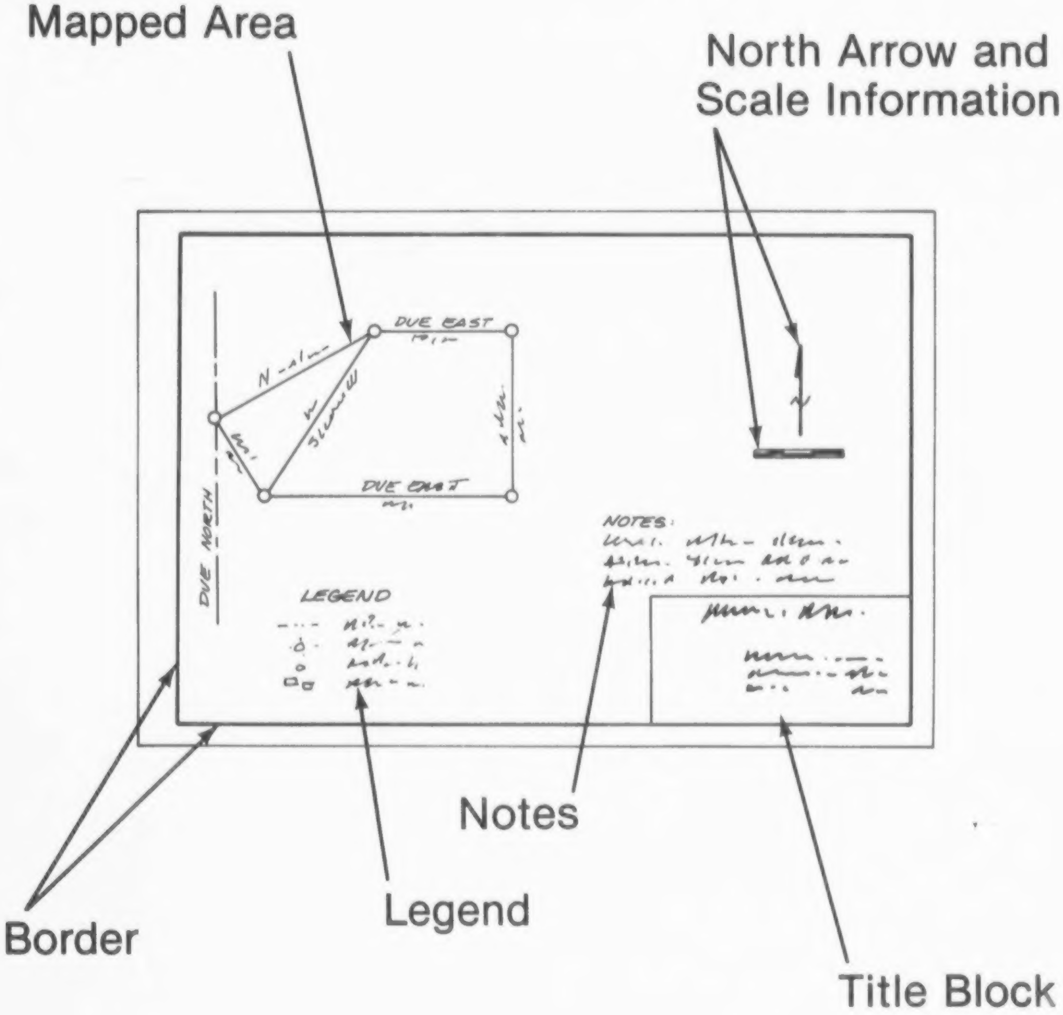
$$\frac{\text{Exist. Sc.}}{\text{Des. Sc.}} = \text{\% of E or R}$$

For percentages to enlarge or reduce inches to inches:

Enlarging — divide smaller number into larger $\frac{\text{Lg. No.}}{\text{Sm. No.}} = \text{\% of E}$

Reducing — divide larger number into smaller $\frac{\text{Sm. No.}}{\text{Lg. No.}} = \text{\% ofR}$

Components of a Map Layout


Mapped Area
North Arrow and Scale Information
DUE EAST
DUE EAST
DUE NORTH
N
NOTES:
LEGEND
Notes
Legend
Border
Title Block

Sample Title Blocks

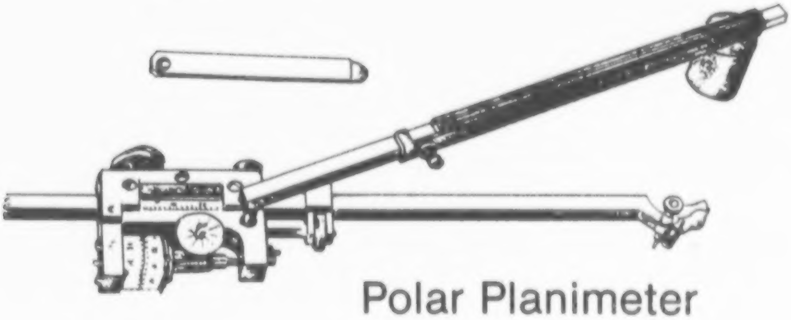
COLORADO SCHOOL OF MINES
CIVIL ENGINEERING DEPARTMENT
TRANSIT - STADIA SURVEY
OF
FILLMORE FIELD
SCALE: 1 in. = 20 ft. DATE: 5-8-86
SURVEY BY: C. EVANS MAP BY: KAS

BENDER & ASSOC.		
PLANNING DEPARTMENT		
DR. BY KAS	KARIN OSTLUND LAND PLANNER	DATE: 3-25-86
SCALE 1" = 200'	TRAFFIC STUDY	DRWG NO. 60-01

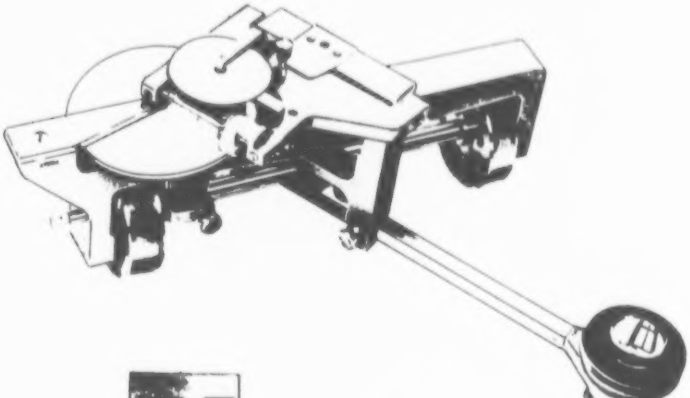
MAP OF MISSOURI
SHOWING
MAJOR WATERWAYS
AND THEIR
DRAINAGE AREAS
Mary Powell
June 1, 1986
Scale of Miles

10
0
10
20
30
40
50

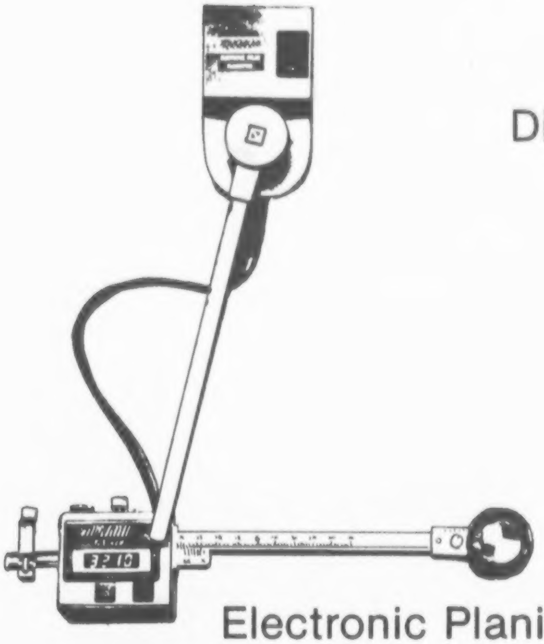
Types of Planimeters



Polar Planimeter



Disc Planimeter



Electronic Planimeter

MAP DRAFTING PROCEDURES
UNIT VI

HANDOUT #1 — EVALUATION OF DRAFTING MEDIA

Evaluation	Type of Material			
	Prepared Tracing Paper	Natural Tracing Paper	Office System	Tracing and Drawing Film
Transparency — Visual or Tracing				
Excellent				●
Very Good	●	●	●	
Good				
Fair				
Transparency — Actinic or Reproductive				
Excellent				●
Very Good	●		●	
Good				
Fair		●		
Strength				
Excellent	●		●	●
Very Good				
Good		●		
Fair				
Erasability				
Excellent	●		●	●
Very Good				
Good		●		
Fair				
Permanence				
Excellent	●		●	●
Very Good				
Good				
Fair		●		
Cost				
High				
Medium				●
Low	●	●		

MAP DRAFTING PROCEDURES
UNIT VI

HANDOUT #2 — CHARACTERISTICS OF UNSENSITIZED FILMS

TYPE	BASE THICKNESS	SURFACE/DESCRIPTION	USES
Transparent Uncoated	.005" .0075"	Clear	For overlays, protective covers, type stick-up, etc.
Transparent for Ink	.003" .005" .0075"	Clear	Accepts ink or airbrush colors. Excellent for overlay work.
Transparent for Pencil and Ink	.005" .0075"	Matte one side	For original layouts — for accurate drafting where close tolerances are required, such as body layouts, air frame structure design, loft molds, etc.
	.005" .0075"	Matte both sides	
Transparent All-Purpose Stylus	.005"	Matte both sides	Has stylus acceptance quality, can also be used with pencil and ink. For lofting and auto industry work where close tolerances are needed.
Opaque for Pencil and Ink	.005" .0075"	White-Matte both sides	Used as master template sheet in conjunction with a photo-electric eye and pantograph for automatic flame cutting of plate. For the same general purposes as mounted drawing paper, and as a base for color proofs.
Cartographic for Ink	.004" .007"	Matte one side	For photogrammetric compilations and drafting phases of map reproduction. Also for use on automated plotting equipment and coordinatographs. Superior inking surface.
	.004" .007"	Matte both sides	
Plot-A-Grid	.003" .005"	Black 90° 5×5" Grid-Matte one side	Designed for use by the mapping, photogrammetry, automotive, and aircraft industries
	.004"	Black 90° 5×5" Grid-Matte both sides	
Scribe Coat	.0075"	White*	Actinically opaque, translucent on light table. For accurate scribe masters where duplicates are to be made. Extensively used for all mapping purposes, including color separation. Also used for scribing business forms. *Not actinically opaque for certain reproduction methods.
	.005" .0075"	Yellow	
	.005" .0075"	Rust	
	.0075"	Green	
Scribe Coat Type S	.005" .0075"	Rust	Requires reduced scribing pressure. Ideal for seismic scribing/recording devices, automatic plotters, and manual scribing operations when material not exposed to heavy duty use.
Outline Scribe	.0075"	White/Green	For undimensional drafting, and for use on automated plotters. The double coating makes scribed image stand out with excellent contrast. Light table not required.
	.005" .0075"	White/Rust	
Transparent Scribe	.005" .0075"	Red	The red film is visually transparent, actinically opaque and is used for overly scribing to produce map features plates.

HANDOUT #2

TYPE	BASE THICKNESS	SURFACE/DESCRIPTION	USES
Peel Coat	.0075"	Deep Orange	For color separation, mapping, heavy lines in printed circuits, open window negatives. Actinically opaque. Use with bichromated colloid resist, etch with alcohol.
Cut 'n' Strip	.005"	Red/Matte other side	For circuit layouts, micro-circuit mask design.
	.005" .0075"	Deep Red/Clear other side	Used for color separating, drop-out masks, laying screen areas,a nd silhouetting halftones and certain mapping uses.

Information Courtesy of Keuffel and Esser.

(NOTE: Films are available in lengths of 20 yards or 50 yards except for cartographic film which is available only in 100-foot lengths. The standard widths on most films are 36, 42, and 48 inches with some films available smaller or larger than this.)

MAP DRAFTING PROCEDURES
UNIT VI

HANDOUT #3 — CHARACTERISTICS OF SENSITIZED FILMS

TYPE	BASE THICKNESS	SURFACE/DESCRIPTION	USES
Pencil & Ink Surface Sensitized for HELIOS Dry Diazo Reproduction	.005"	Black Line-Sensitized glossy side	Make 2nd originals from positive drafts. For accurate reproductions to send to subcontractors. Use as direct templates for checking pattern, hole placement, etc. Standard speed.
	.005"	Sepia Line-Sensitized glossy side	Same as above, except Rapid speed.
Scribe Surface Sensitized for HELIOS Dry Diazo Reproduction	.0075"	Black Line-Rust Surface	Used where guidelines image is required on scribe surface, in mapping operations.
Peel Coat Sensitized for Photographic Reproduction	.0075"	Daylight Working Contact Dark Red	Used to make open window negatives for open water areas, urban areas, woodland tints where scribed or photo negative original is used as outline master. Photo sensitive acts as a stencil resist for chemical etching.
Reproscribe Sensitized for Direct Positive	.0075"	Photographic contact emulsion on soft Rust Scribe. Daylight Handling.	Used to duplicate existing scribe negatives or produce a scribe negative from a positive drawing. Ideal for master revision work.

Information Courtesy of Keuffel and Esser.

MAP DRAFTING PROCEDURES
UNIT VI

ASSIGNMENT SHEET #1 — COMPLETE A TRACING IN INK OF A MAPPED AREA

Directions:

1. Using the layout for the "Missile Complex" completed in Assignment Sheet #6, Unit IV, set up a final map for presentation.
2. Determine final sheet size for map to be drafted.
3. Complete in ink on film.

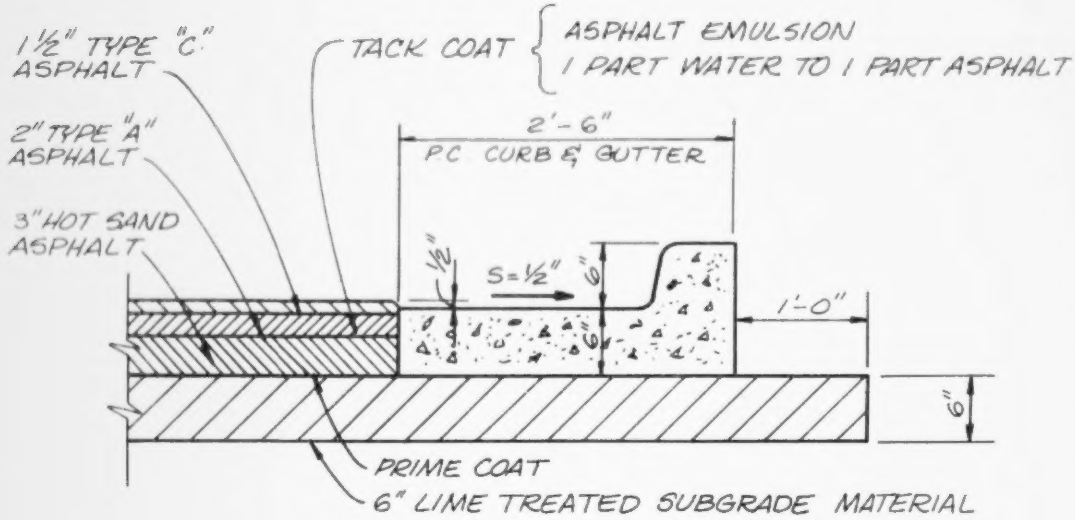
   (NOTE: Determine the line weights with your instructor.)
4. Include all necessary information:
   - a. Title block and border
   - b. Legend
   - c. North meridian
   - d. Graphic scale
   - e. Notes
5. Hand letter dimensions in ink.
6. Use mechanical lettering or press-on letters for the title block information.
7. Run diazo print.

MAP DRAFTING PROCEDURES
UNIT VI

ASSIGNMENT SHEET #2 — APPLY TRANSFER FILM AND PRESS-ON LETTERS

Directions:

1. Use "B" size polyester film (such as Mylar).
2. Trace the details shown below and on the next page in ink on the drafting film.
3. Hand letter the notes and dimensions.
4. Use applique transfer film for the material symbols.
5. Use press-on letters for the titles.

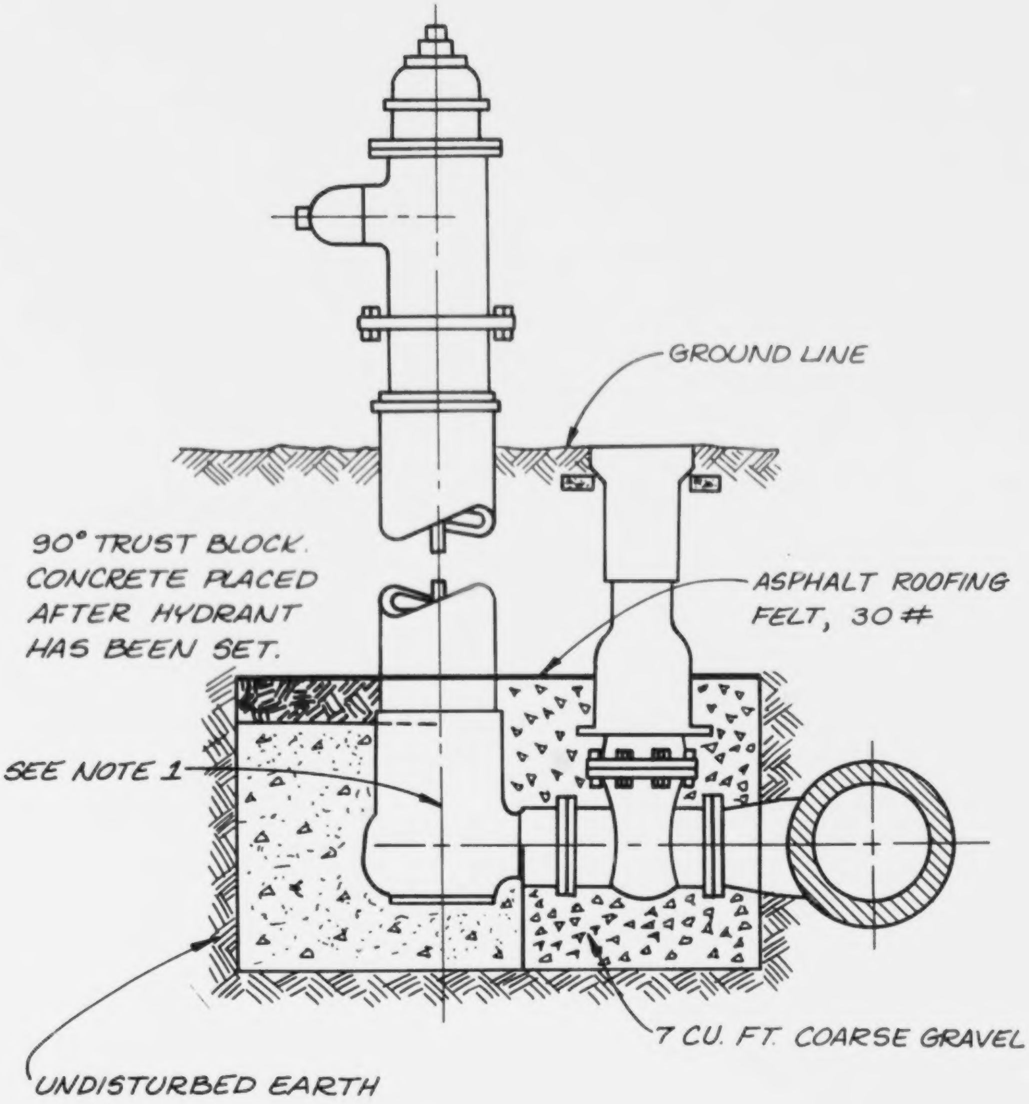


1½" TYPE "C" ASPHALT
TACK COAT
ASPHALT EMULSION
1 PART WATER TO 1 PART ASPHALT
2" TYPE "A" ASPHALT
2'-6"
P.C CURB & GUTTER
3" HOT SAND ASPHALT
½"
S=½"
6"
6"
1'-0"
6"
PRIME COAT
6" LIME TREATED SUBGRADE MATERIAL

NOTE:
PRIME COAT SHALL BE SS-1
ASPHALT EMULSION 9 PART
WATER TO 1 PART ASPHALT

DETAIL OF 6½" ASPHALT
CONCRETE PAVING

ASSIGNMENT SHEET #2


GROUND LINE
90° TRUST BLOCK. CONCRETE PLACED AFTER HYDRANT HAS BEEN SET.
ASPHALT ROOFING FELT, 30 #
SEE NOTE 1
7 CU. FT. COARSE GRAVEL
UNDISTURBED EARTH
LEAVE DRAIN ACCESSIBLE
POUR TO TRENCH LIMITS
FOR SIDES.

FIRE HYDRANT

MAP PLANNING PROCEDURES
UNIT VI

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1 — To be evaluated on neatness, balance of the map, and line quality to the satisfaction of the instructor.

Assignment Sheet #2 — Evaluated to the satisfaction of the instructor.

MAP DRAFTING PROCEDURES
UNIT VI

JOB SHEET #1 — REGISTER A MAP

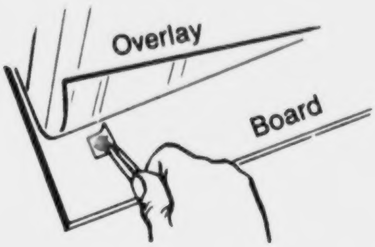
A. Tools and materials

1. Sheet of transfer register marks
2. Art boards, 2
3. Clear, overlay sheets (acetate), 2
4. Art knife
5. Burnisher
6. Hole puncher
7. Register pins, 2

B. Procedure for register marks method

1. Remove one register mark from transfer sheet using art knife.
2. Position register mark on your art board and cover with overlay sheet. (Figure 1)

FIGURE 1



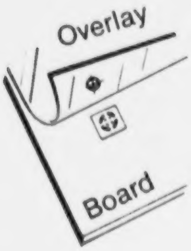
3. Remove a matching register mark from transfer sheet.

JOB SHEET #1

4. Position second register mark on overlay directly over first register mark. Use great care to assure perfect registration. (Figure 2)

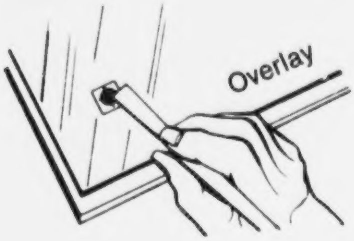
   (NOTE: This procedure can be repeated for multiple overlays.)

   FIGURE 2



5. Burnish the register marks. (Figure 3)

   FIGURE 3



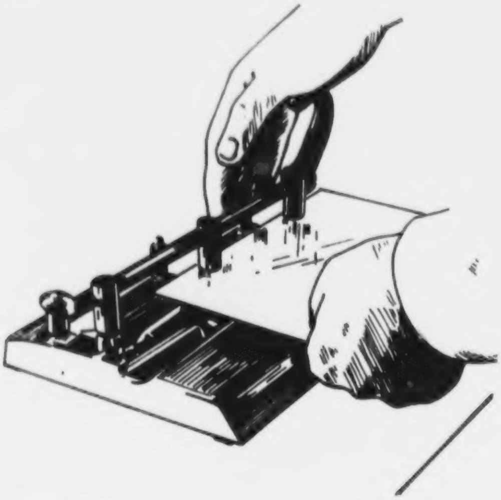
C. Procedure for pin registration method

   1. Trim a piece of board and an overlay sheet to the same size.

JOB SHEET #1

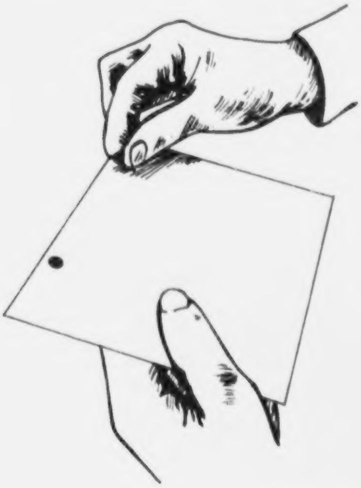
2. Punch two holes in them at the same time. (Figure 4)

FIGURE 4



3. Push a register pin through each of the holes from the back side of the board. (Figure 5)

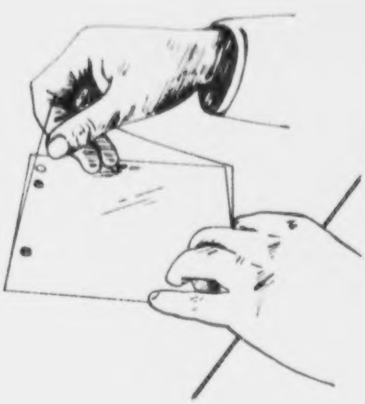
FIGURE 5



JOB SHEET #1

4. Place the punched overlay on the pins. (Figure 6)

FIGURE 6



MAP DRAFTING PROCEDURES
UNIT VI

JOB SHEET #2 — USE A POLAR PLANIMETER TO DETERMINE ACREAGE

A. Material

1. Polar planimeter

2. Map area to be measured

3. Paper and pencil for recording results

B. Procedure

1. Set planimeter in place. Position pole outside the area to be measured. Test to see if the tracer arm can reach all around the area to be measured.

   (NOTE: If area is too large for one swing around it, establish one or more division lines. Planimeter each part and add them together.)

2. Zero up the dials or read the initial reading and record.

   (NOTE: Refer to the manual for instructions on your planimeter.)

3. Trace around area to be measured in a clockwise direction.

4. Record the number on the dial.

   a. Fixed arm planimeter: If length on tracer arm (AT) is set without the ability to adjust, it is usually set at a ratio of 1:10.

      Example: 1"×1" square = 1.00 revolutions
      Therefore, area traced = Number of revolutions × 10

   b. For planimeter with adjustable arm, allow for different settings.

      Example: 1"= 20 up to 1"= 200'
      Set for a linear scale means 1 square inch = 400 square feet.

5. If using a fixed arm planimeter, multiply your number of revolutions by the number of square feet (at map scale).

   Example: If map scale is 1" = 50', then 1 square inch on map = 2500 sq. ft.
   Number of sq. ft. × number of revolutions = Total sq. ft.
   2500 sq. ft. × 1 revolution = 2500 sq. ft.

JOB SHEET #2

6. Divide the number of square feet in one acre (43,560 sq ft in 1 acre) into the number of square feet of the area being measured. This will give you the number of acres in the area to be measured.

   Example: 2500 sq. ft. ÷ 43,500 sq. ft. = .057 acres

7. For greater accuracy of results, planimeter each area three times and average the results.

MAP DRAFTING PROCEDURES
UNIT VI

NAME ____________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. A surface that has a bright, polished finish

_____b. Brand name of a polyester film used as a base for drawing in the drafting industry

_____c. Admitting and diffusing light so that objects beyond cannot be clearly distinguished; partly transparent

_____d. A clear plastic film which has no drafting surface

_____e. A drawing medium that is matte on one or both sides for a drafting surface; accepts both ink and pencil and comes in various mil thicknesses

_____f. A tool generally used to rub film, letters, or symbols onto a drawing to assure the adherence to the drafting medium

_____g. A material used to carry information; in drafting, includes various papers and films used for written and drafted information

_____h. An original drawing on a translucent material suitable for diazo reproduction

_____i. A diazo product used in the reproduction process of maps and topos; either negative or positive images can be placed on this film, with more drafting added later as needed

_____j. A slightly rough finish free from shine or highlights

_____k. Not permitting the passage of light

_____l. A thin film with a tacky surface that will adhere to another drawing; used to block out areas on a map or drawing

_____m. A precision instrument used to measure plane areas of any shape

1. Acetate
2. Burnisher
3. Gloss
4. Matte
5. Medium
6. Mylar
7. Opaque
8. Peelable film
9. Planimeter
10. Polyester film
11. Reproducible
12. Scribing/engraving instruments
13. Sensitized material

TEST

_____n. Transmitting light without appreciable scattering so that bodies lying beyond are clearly visible

_____o. A prepared tracing paper that has the quality of strength and transparency to make a good drawing surface; generally used with pencil and ink

_____p. Similar to mechanical instruments except that the drawing points are cutters or metal tips

_____q. A master sheet of letters or symbols that can be easily transferred to a drawing by rubbing the symbol with a blunt instrument onto the proper place on the drawing

14. Transfer overlay
15. Translucent
16. Transparent
17. Vellum

2. Match the types of drafting media on the right with their characteristics.

_____a. 100% rag translucent paper which accepts pencil and ink

_____b. Used for quick notes or changes over a drawing

_____c. May be sensitized for special diazo reproduction process or unsensitized for standard work; are available with single or double matte surfaces which accept ink, pencil, or plastic film lead; are available in different mil thicknesses (.002" to .007")

_____d. Film or paper printed with black or blue 90° grids with single or double matte surfaces

_____e. An opaque-coated polyester film

_____f. A peelable film used for color separations and map drafting

1. Gridded media
2. Peel coat
3. Natural tracing paper
4. Prepared tracing paper (vellum)
5. Scribe coat
6. Tracing and drawing polyester films

3. Select the following true statements concerning characteristics of scribing by placing an "X" in the appropriate blanks.

_____a. Is only used for wide tolerance work.

_____b. Is usually worked over a light table.

_____c. Lines are created by using a technical pen to incise the special surface.

_____d. Corrections cannot be made in scribed surface.

TEST

______e. Lines are clean, sharp, and of a uniform width.

______f. Finished drawing is the positive image for reproduction.

______g. Produces a dimensionally-stable original.

4. Match types of photographic block-out products on the right with the correct characteristics.

______a. A light safe, polyester film coated with a low tack, repositionable adhesive

______b. A thin, light safe film coated on a clear dimensionally-stable polyester base sheet available in ruby red or amber; .003 mil or .005 mil thickness

______c. Produces a peelable negative after film processing

______d. Available in widths 1/32" to 1"

______e. Used for small spots for instant opaquing

1. Block-out film
2. Litho blockout tapes
3. Masking film
4. Opaquing pen
5. Peel coat

5. List three types of lettering used in civil drafting.

a. ______________________________

b. ______________________________

c. ______________________________

6. Complete the following statements concerning rules for good lettering by filling in the blanks with the correct words.

a. Use lettering aids to provide guidelines to obtain uniform ______________ in lettering.

b. Lettering usually varies in size on maps in direct relation to the ______________ of the item to be lettered.

c. Lettering should be placed so it is readable from the bottom and the ______________-hand side of the drawing.

d. Lettering for railroads, roads, and waterways on maps should be parallel and close to the ______________.

TEST

7. Distinguish between the methods of map registration by placing an "X" next to the description of register marks.

______a. Decals or hand-drawn targets that line up on a base sheet with corresponding marks on the overlay

______b. Uses a metal strip with projecting pins and stable polyester film properly punched on one edge at corresponding spaces to provide precise registration

8. Match the reprographic techniques on the right with the correct uses in civil drafting.

______a. Application of ink on a drawing, usually executed on film with technical pens or ruling pens.

______b. Can be used in place of ink lines for faster application or to provide a pattern or color line; reproduces well.

______c. A material with an adhesive backing that can be applied to drawings to fill in a section with color, pattern, or applied symbol(s).

______d. Photographic reproduction of text information at any required point size for paste up on a final map or for manual preparation.

______e. Techniques used during the photographic reproduction of a drawing to change its size or appearance.

______f. Used for duplication and quick reproductions; enlargements, reductions, and color copies are also possible.

______g. Produces 1:1 scale blueline, blackline, or sepia paper or film prints from reproducible originals; relatively inexpensive but quality and shelf life are poor.

1. Diazo reproduction
2. Inking
3. Photographic methods
4. Pressure-sensitive film
5. Taping
6. Typesetting
7. Xerographic copying

9. List four types of pressure-sensitive film.

a. ____

b. ____

c. ____

d. ____

TEST

10. List two methods used for coloring maps.

a. ______________________________

b. ______________________________

11. Complete the following statements concerning aerial photography by selecting the best answer and placing the corresponding number in the blank provided for each.

_____a. All of the following are applications of aerial photography **EXCEPT**:

1) Stereo compilation
2) Orthographics
3) Orthophotography
4) Photo interpretation

_____b. Analytical aerotriangulation produces coordinates of photo control points by ____________ procedures.

1) Mathematical
2) Analog
3) Tactile
4) Visual

_____c. Aerial photographs overlap each other ____________ along flight lines.

1) 30%
2) 40%
3) 50%
4) 60%

_____d. Stereoviewing of aerial photographs creates a ____________-dimensional model.

1) 1
2) 2
3) 3
4) 4

_____e. The scale of the aerial photograph is identified ____________ taking the photograph.

1) Before
2) After

_____f. A series of aerial photographs that are taken along a given flight line combined into one large photograph is called a ____________.

1) Photo collage
2) Photo map
3) Photo mosaic
4) Photo arrangement

TEST

12. List three methods of drawing reproduction.

a. ____________________

b. ____________________

c. ____________________

13. Arrange in order the standard sheet format for a set of civil drawings by placing the correct sequence numbers (1-6) in the appropriate blanks.

_____a. Construction details

_____b. Notes

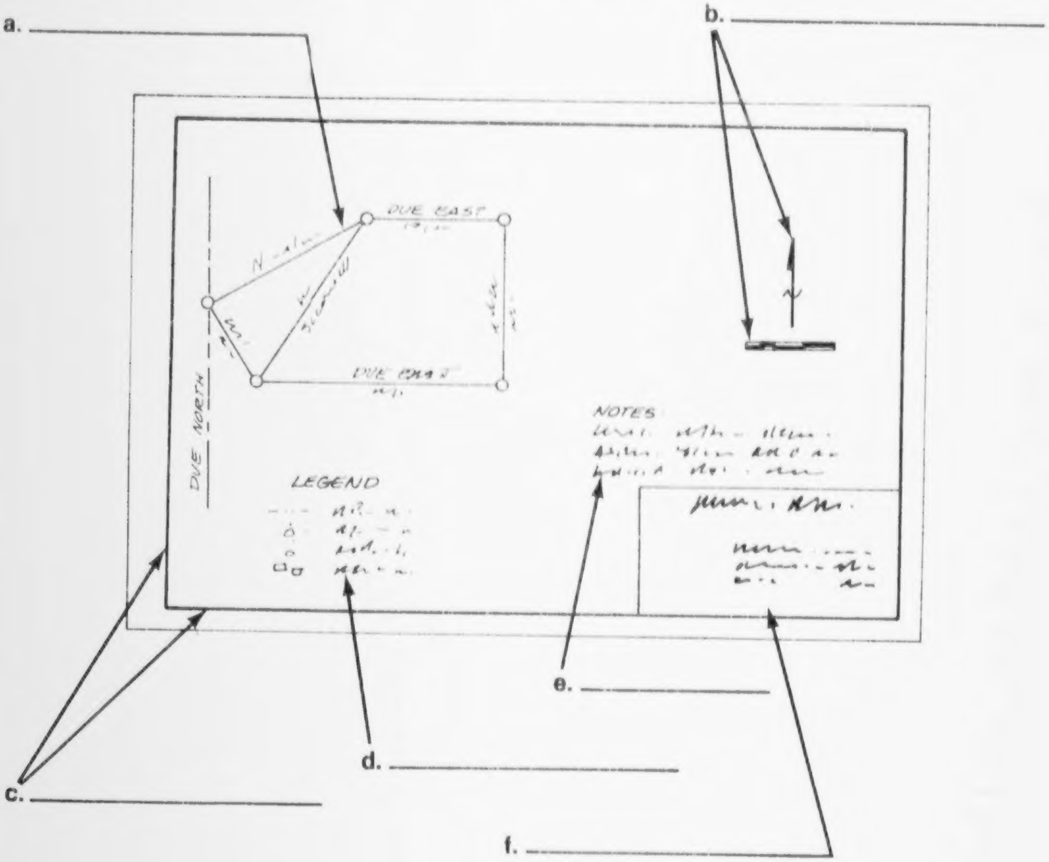
_____c. Area map

_____d. Cover sheet — key map

_____e. Cross sections

_____f. Plan and profiles

14. Label the components of the following map layout.


a. ____________________
b. ____________________
DUE EAST
DUE NORTH
DUE EAST
NOTES
LEGEND
e. ____________________
d. ____________________
c. ____________________
f. ____________________

TEST

15. Arrange in order the following steps for drafting a map or drawing by placing the correct sequence numbers (1-8) in the appropriate blanks.

_____a. Lay in the border.

_____b. Locate the meridian arrow.

_____c. Place the title block.

_____d. Letter in the notes.

_____e. Plot in map area on a layout sheet.

_____f. Place the legend.

_____g. Select sheet medium (film or paper) and size.

_____h. Perform final inking.

16. List six common mistakes made in map drafting.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

17. Distinguish between the types of planimeters by placing the following letters next to the correct descriptions:

"D" — Disc planimeter
"E" — Electronic planimeter
"P" — Polar planimeter

_____a. Fixed arm type measures areas in square inches or square centimeters, then multiplied by a factor.

_____b. Is recommended for use on maps or charts that have been reduced to a small scale.

_____c. Has a digital readout of the area measured.

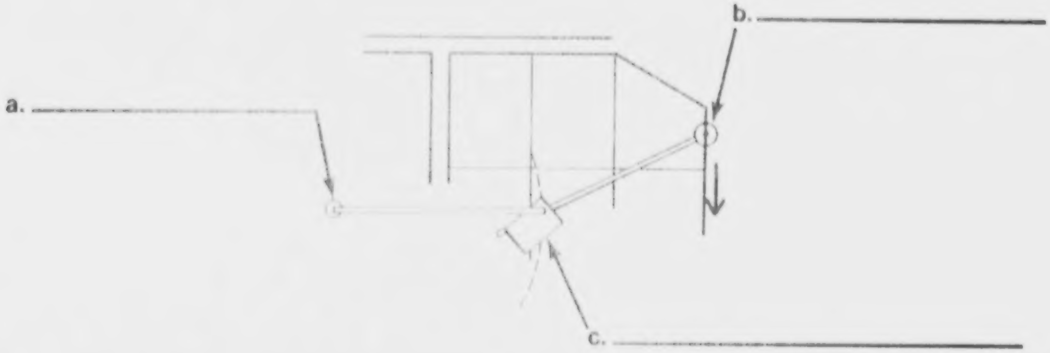
_____d. Is considered more precise than the polar planimeter..

_____e. Adjustable arm type can be set to a variety of ratios for direct reading from the dial.

_____f. Minimizes the possibility of decimal mistakes.

TEST

18. Label the parts of the following polar planimeter.



(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

19. Complete a tracing in ink of a mapped area. (Assignment Sheet #1)

20. Apply transfer film and press-on letters. (Assignment Sheet #3)

21. Demonstrate the ability to:

    a. Register a map. (Job Sheet #1)

    b. Use a polar planimeter to determine acreage. (Job Sheet #2)

MAP DRAFTING PROCEDURES
UNIT VI

ANSWERS TO TEST

1. a. 3
   b. 6
   c. 15
   d. 1
   e. 10
   f. 2
   g. 5
   h. 11
   i. 13
   j. 4
   k. 7
   l. 8
   m. 9
   n. 16
   o. 17
   p. 12
   q. 14

2. a. 4
   b. 3
   c. 6
   d. 1
   e. 5
   f. 2

3. b,e,g

4. a. 1
   b. 3
   c. 5
   d. 2
   e. 4

5. a. Hand lettering in pencil or ink using Gothic or Roman styles
   b. Mechanical lettering
   c. Lettering machines
   d. Press-on letters

6. a. Height
   b. Importance
   c. Right
   d. Symbol

7. a

8. a. 2
   b. 5
   c. 4
   d. 6
   e. 3
   f. 7
   g. 1

9. Any four of the following:
   a. Pattern films
   b. Shading films (screens)

ANSWERS TO TEST

c. Symbol sheets
d. Color films
e. Custom transfers
f. Title block transfers (standard or custom)
g. Transfer film
h. Rubber stamp

10. Any two of the following:
    a. Colored pencils
    b. Felt tip markers (Magic markers)
    c. Color separations; photographic processes in the printing of maps
    d. Color transfer films

11. a. 2
    b. 1
    c. 4
    d. 3
    e. 1
    f. 3

12. Any three of the following:
    a. Diazo print — Blueline or blackline paper or film prints
    b. Intermediate (sepia or black)
    c. Xerographic copying
    d. Photo engraving
    e. Photo offset printing

13. a. 5
    b. 6
    c. 2
    d. 1
    e. 4
    f. 3

14. a. Mapped area
    b. Meridian arrow
    c. Border
    d. Legend
    e. Notes
    f. Title block

15. a. 2
    b. 5
    c. 4
    d. 7
    e. 3
    f. 6
    g. 1
    h. 8

16. Any six of the following:
    a. Not checking (scaling distances when plotting by coordinates)
    b. Plotting by protractor

ANSWERS TO TEST

- c. Using a soft pencil or one with a blunt point
- d. Variation in dimensions of map sheet due to temperature and moisture
- e. Selecting an inappropriate scale or contour interval for the map
- f. Improperly orienting topographic notes in field or office
- g. Using wrong edge of engineer's scale
- h. Making the north arrow too large, complex, or black
- i. Omitting the scale or necessary notes
- j. Failing to balance the sheet by making a preliminary sketch
- k. Drafting the map on a poor-quality medium

17. a. P
    b. D
    c. E
    d. D or E
    e. P
    f. E

18. a. Pole
    b. Tracer
    c. Counter box

19.-20. Evaluated to the satisfaction of the instructor.

21. Performance skills evaluated to the satisfaction of the instructor.

PLATS AND SUBDIVISIONS
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to plan a preliminary subdivision map, complete a final plat map, and layout a plat from a legal description and field notes. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to plats and subdivisions with the correct definitions.
2. Define subdivision planning.
3. Select from a list the official agents who may regulate subdivision planning.
4. List duties that may be performed by regulatory agents for the subdivision of land.
5. Arrange in order the steps in planning a subdivision.
6. Complete statements concerning the final recordation of a subdivision plat map.
7. Select individuals who certify and approve the final plat map.
8. Complete statements concerning legal descriptions.
9. List guidelines for drafting a plat.
10. List methods for laying out and developing a map.
11. Layout a boundary survey from a legal description. (Assignment Sheet #1)

OBJECTIVE SHEET

12. Reduce field notes and plot a simple boundary survey. (Assignment Sheet #2)
13. Develop from field notes the plat map for a nine lot subdivision. (Assignment Sheet #3)
14. Redraw to scale a complete final plat of a 36 lot subdivision. (Assignment Sheet #4)
15. Research the plat information for your property or a property in your area. (Assignment Sheet #5)

PLATS AND SUBDIVISIONS
UNIT VII

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Set up a visit to your local planning office and look at the plat books.
2. Obtain a copy of your local subdivision drafting standards from your planning office or city engineer.
3. Invite your city engineer to speak to your class.
4. Obtain the legal description for the property your school is on and draft a plat showing the boundary and exact location of the school.
5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1 — Preliminary Plat Guidelines
2. TM 2 — Preliminary Plat Guidelines (Continued)
3. TM 3 — Final Plat Check List
4. TM 4 — Final Plat Check List (Continued)
5. TM 5 — Sample of Title Sheet Information
6. TM 6 — Example of a Legal Description
7. TM 7 — Types of Land Descriptions Used in a Legal Description

D. Assignment sheets

1. Assignment Sheet #1 — Layout a Boundary Survey From a Legal Description
2. Assignment Sheet #2 — Reduce Field Notes and Plot a Simple Boundary Survey
3. Assignment Sheet #3 — Develop From Field Notes the Plat Map for a Nine Lot Subdivision
4. Assignment Sheet #4 — Redraw to Scale a Complete Final Plat of a 36 Lot Subdivision
5. Assignment Sheet #5 — Research the Plat Information for Your Property or a Property in Your Area

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

B. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

C. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

D. *Surveying.* Sacramento, CA: California State Department of Education, 1966.

E. *Subdivision Attachments Standard Requirements.* City & County of Boulder, City Planning Department, 1982.

PLATS AND SUBDIVISIONS
UNIT VII

INFORMATION SHEET

I. **Terms and definitions**

A. Bench mark — A relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known

B. Cadastral survey — A survey which creates, marks, defines, retraces, or reestablishes the boundaries and subdivisions of the land

C. Corner — A point on the surface of the earth, determined by the surveying process, which defines an extremity on a boundary of public lands

D. Corner description — The specific data (both old and new) about a corner monument and its accessories, which include marks, positions, and physical characteristics

E. Cul-de-sac — A dead-end street which widens sufficiently at the end to permit an automobile to make a "U" turn

F. Datum line — In ordinary survey usage, a defined reference line for survey measurement

G. Easement — An interest or right in land owned by another that entitles its holder to a specific limited use, such as laying a sewer, crossing over property, or putting up power lines

H. Grade plan — A plan containing original ground contours over which contours of the highway, subdivision, or other embankment or excavation to be completed are superimposed on and connected with the original ground contours at the edge of construction limits

I. Legal description — A written statement recognized by law as to the definite location of a tract of land by reference to a survey, recorded map, or adjoining property

J. Monument — A physical structure, such as an iron post, marked stone, or tree in place, which marks the location of a corner point established by a cadastral survey

K. Planning commission — Either a citizen committee appointed by the chief executive or legislative body to review subdivision plans, or a full- or part-time staff of professional planners hired to carry out continued planning activities, review subdivision plans, conduct studies, etc.

L. Plat, subdivision — A map of a subdivision of land usually prepared in accordance with state plat statutes or local subdivision regulations or both

INFORMATION SHEET

M. Plat, use — The component of the new status records, a copy of the master title plat which shows in addition to survey, ownership, and restrictive data, leases, licenses, and permits currently effective

N. Platting — The process of preparing a plat of subdivision according to state and local ordinances

O. Plot — To place survey data upon a map or plat

(NOTE: In the past, no clearly defined difference existed between plat and plot. It is recommended to use plat for graphic representation of the survey and plot for the cartographic operations involved in the construction of a map or plat.)

P. Subdivision plat book — A public record showing the location, size, and name of owners of various recorded plats in the municipality or county

II. **Subdivision planning —** The process of dividing urban land into orderly, accurately surveyed parcels

III. **Official agents who may regulate the subdivision of land**

A. City and county planning commission

B. City council

C. County commissioners

IV. **Duties that may be performed by regulatory agents for the subdivision of land**

A. Draw up zoning and building regulations

B. Establish rules for building height limits, parking facilities, and right-of-way setback lines

C. Establish specifications for improvements on:

1. Sewers
2. Water lines
3. Sidewalks
4. Curbs
5. Gutters
6. Street paving

INFORMATION SHEET

D. Grant permits for sale of new subdivision lots

E. Establish utility regulations

V. **Steps in planning a subdivision** (Transparencies 1 and 2)

(NOTE: The steps in planning a subdivision will vary from locale to locale. Consult the specific procedures used in your area.)

A. Planning office and city engineer are consulted for governing rules and regulations of the local planning agencies specifying the following:

1. Frontage and depth of lots
2. Minimum and maximum length of blocks
3. Street widths
4. Maximum street gradients
5. Minimum street gradients
6. Allowable direction of lot lines in respect to the streets
7. Design consideration of residential subdivisions
8. Width of right-of-ways for city streets
9. Width of alleys
10. Minimum required clearance from residential buildings to property lines

B. A small scale location map is developed to show the relation of the subdivision to the surrounding properties.

C. A tentative plan is developed to show the following:

1. Outline of property
2. Proposed title of the subdivision

   (NOTE: This should be checked with the planning office to ensure it is not already in use.)

3. Drawn to a scale of 1" = 200' or larger

   (NOTE: This is often drawn to the same scale as the final plat map, but not always.)

INFORMATION SHEET

4. Topographic features of existing conditions
5. Owner's and surveyor's name
6. Recorded titles of adjoining tracts
7. Proposed layout of lots, streets, alleys, walkways, parks, and any special features
8. All existing easements for a pipeline, power line, etc.
9. Legal description of land (usually only in caption form)
10. The following items will either have documentary references or an explanation of their status:
    - a. Water
    - b. Sewer
    - c. Flood and drainage conditions
    - d. Street improvements
    - e. School facilities
    - f. Parks and recreation
    - g. Power and street lights
    - h. Gas
    - i. Fire protection
    - j. Hospitals
    - k. Transportation
    - l. Access to highways

D. The tentative map is presented for review to the clerk of the advisory agency such as the planning commission.

E. After the tentative plan is approved and all changes are made, a final subdivision plat is drawn up, and then has to receive final approval from the appropriate governing agency.

INFORMATION SHEET

VI. The final recordation of a subdivision plat

A. The final plat is considered a legal working document and will be on file at the county courthouse.

B. It is drawn at a scale of 1" = 100' or larger.

C. Listed are some of the requirements for a final plat. (Transparencies 3 and 4)

(NOTE: Requirements for the final plat may vary in your locale. Check with the local governing agency for the requirements in your area.)

1. Legal description of the property
2. Property lines, dimensions, and bearings
3. Direction of north
4. All roads, existing and proposed
5. Driveways, patio slabs, parking areas, and walkways
6. Proposed and existing structures
7. Location of well and/or water service line, location of wells on adjacent properties
8. Location of proposed gas and power lines
9. Location of septic tank, drainfield, drainfield replacement area, and/or sewer
10. Dimensions and spacing of soil absorption field or leach lines, if used
11. Location of soil test holes, if used
12. Proposed location of rain drains, footing drains, and method of disposal
13. Ground elevation at lot corners, and street elevation at driveway centerline
14. Slope of ground
15. Proposed elevations of main floor, garage floor, and basement or crawl space
16. Proposed setback from all property lines

INFORMATION SHEET

17. Utility and drainage easements
18. Natural drainage channels
19. Total acreage
20. Drawing scale
21. Necessary signatures of certification

D. Title sheet will include: (Transparency 5)

1. Certification signatures
2. Caption type description
3. Basis of bearing
4. Monument note
5. Bench mark, if required
6. Legend, if required
7. Omission of certain signature, if applicable
8. Index map of subsequent sheets, if many
9. North arrow and scale
10. Soil test report, if required
11. Any special notes

E. The final plat may include

1. Grading plan
2. Plan and profiles for utilities
3. Plan and profile for street improvements

F. Accuracy of boundary closure varies based on value of land according to state law.

VII. **Individuals who certify and approve a final plat map** (Transparency 5)

A. Private engineer or surveyor

B. Public engineer or surveyor

C. Financial institution — mortgage release

INFORMATION SHEET

D. Title company — title opinion

E. Owner

F. City agent

G. Utility companies

H. Clerk and recorder

VIII. **Characteristics of legal descriptions** (Transparencies 6 and 7)

A. Are written descriptions describing the relationship of a parcel of land to the surrounding surveys

B. A complete description will begin with the smallest division and progress to the largest.

C. A complete description can include all three types of land descriptions: (Transparency 7)

1. Public land sectional system to identify the point of beginning.
2. Metes and bounds to describe the boundary lines.
3. Lot and block description can be used as an alternate description.

IX. **Guidelines for drafting a plat**

A. A datum line must be established and elevations shown (these elevations are taken from a benchmark)

B. Use symbols to represent lakes, ponds, rivers, etc.

C. Indicate the compass orientation of the lot

D. Show lot corners by small circles

E. Show property lines

F. Show corner elevations above the datum

G. Show changes in contours by dashed or dotted lines

H. Show new grade (N.G.) and final grade (F.G.)

I. Show dimensions from property lines to utility lines

J. Show any easements (these may be determined by building codes)

INFORMATION SHEET

K. Show all encroachments to the property

L. Indicate owner and legal description

M. Show lot number and addition where it is located

N. Label utility lines

O. Show scale

(NOTE: Usually a civil engineer's scale is used.)

X. Three methods for laying out and developing a map

A. Plotting the boundary from the legal description

B. Plotting by coordinates

C. Plotting by latitudes and departures

Typical Preliminary Plat Guidelines

☐ Any preliminary plat submitted for subdivision approval shall be drawn to a scale of no less than one inch equals one hundred feet, but of a sufficient scale to be clearly legible, including streets and lots adjacent to the subdivision.

☐ The proposed name of the subdivision.

☐ Location and boundaries of the subdivision, names of all abutting subdivisions with lines indicating abutting lots, or if the abutting land is unplatted, a notation to that effect, and names of all abutting streets.

☐ Contours at two foot intervals if the slope is less than ten percent and five feet where the slope is greater than ten percent.

☐ Date of preparation, scale, and north sign (designated as true north).

☐ A vicinity map showing at least three blocks on all sides of the proposed subdivision, which may be of a different scale than the plat.

☐ Location of structures and trees of five inch caliper or more on the property and approximate location of structures off the property within ten feet of the property line.

☐ Name, address, and telephone number of the licensed surveyor, licensed engineer, or designer of the plat.

☐ Name, address, and telephone number of owner and verification of ownership of the property and current title information by either a preliminary title report or an attorney memorandum based upon an abstract of title, current as of the date of the submittal.

☐ Total acreage.

☐ Location and dimensions of all proposed public improvements, easements, drainage areas, irrigation ditches and laterals, and other significant features within or adjacent to the property.

☐ Location and dimensions of all proposed public improvements, public easements, lot lines, and parks and other areas to be reserved or dedicated for public use.

☐ Geological stability information upon request of the City Manager if the manager determines or the subdivider has any reason to believe that building or other problems may arise from construction in the area proposed for development.

Typical Preliminary Plat Guidelines

(Continued)

☐ Zoning on and adjacent to the property.

☐ Designation of areas subject to the one-hundred year flood and the estimated flow rate used in determining that designation.

☐ The number of lots and each lot size.

☐ Proposed use of each lot.

☐ Proposed ownership and use of outlots.

☐ The location and size of existing utilities within or adjacent to the property including without limitation, water, sewer, storm sewers and drainage facilities, fire hydrants within three hundred fifty feet of the property, electricity, and gas, which shall be placed on separate engineering drawings.

☐ A master utility plan showing proposed plans for private and public utility systems including water, sewer, electric, gas, drainage, telephone, telecommunications, and any other services that will supply the property.

☐ Names and addresses of all tenants of the property and all owners of property abutting the property.

☐ Identification of the public improvements, easements, parks, other public facilities shown on the plat and a dedication thereof to the public use, and areas reserved for future public acquisition.

Typical Final Plat Check List

☐ A map of the plat drawn at a scale of no less than one inch equals one hundred feet (and of a sufficient scale to be clearly legible) with the use of permanent lines in ink and whose outer dimensions of the map at 24" × 36" on a reproducible polyester film (maps of two or more sheets shall be referenced to an index map placed on the first sheet).

☐ A one inch equals one hundred feet reduction of the plat.

☐ The title under which the subdivision is to be recorded.

☐ Accurate dimensions for all lines, angles, and curves used to describe boundaries, public improvements, easements, areas to be reserved for public use, and other important features. (All curves shall be circular arcs and shall be defined by the radius, central angle, tangent, arc, and chord distances. All dimensions, both linear and angular, are to be determined by an accurate control survey in the field that must balance and close within a limit of one in ten thousand. No final plat showing plus or minus dimensions will be approved.

☐ Names of all abutting subdivisions, or if the abutting land is unplatted, a notation to that effect.

☐ An identification system for all lots, blocks, and names for streets.

☐ An identification of the public improvements, easements, parks, other public facilities shown on the plat and a dedication thereof to the public use, and areas reserved for future public acquisition.

☐ The total acreage and surveyed description of the area.

☐ The number of lots and size of each lot.

☐ Proposed ownership and use of outlots.

☐ A designation of areas subject to the one-hundred year flood, the estimated flow rate used in determining that designation, and a statement that such designation is subject to change.

☐ A description of all monuments, both found and set, that mark the boundaries of the property, and a description of all control monuments used in conducting the survey.

☐ A statement by the land surveyor that the survey was performed in accordance with state law.

☐ A statement by the land surveyor explaining how bearings, if used, were determined.

☐ The signature and seal of the state registered land surveyor.

Typical Final Plat Check List

(Continued)

☐ A delineation of the extent of the one-hundred year flood-plains, the effective date thereof, and a statement that they are subject to change.

☐ Square footage of each lot.

☐ Certification for approval by the following:

A) Director of Planning and Community Development
B) Director of Public Works and Utilities
C) Director of Parks and Recreation
D) Director of Real Estate and Open Space
E) Telephone Company
F) Public Service Company

☐ Signature blocks for all owners with an interest in the property.

☐ Signature block for Mayor's signature.

☐ Engineering drawings for proposed public and private utility systems meeting the requirements of the City Public Works Department's "Design Criteria and Standard Specifications."

☐ An update to the preliminary title report or attorney memorandum based upon an abstract of title current as of the date of submitting the plat.

☐ Convenants for maintenance of private utilities or improvements, as prescribed.

☐ Copies of documents granting any easements required as part of the plat approval, the County Clerk and Recorder's recording number, and proof of ownership of the property underlying the easement satisfactory to the City Attorney.

☐ The subdivider shall provide to the City a computer check to assure that the exterior lines of the subdivision on the final plat close. In the absence of such verification, the City shall obtain such computer check, and the subdivider shall pay the fee therefore prescribed before recording the plat.

☐ When submitting a final plat, the subdivider shall also file with the City Manager fees prescribed, agreements with ditch companies, if needed, engineering plans, and financial guarantees required.

Sample of Title Sheet Information

ARBOR GLEN SUBDIVISION

FINAL PLAT

A SUBDIVISION OF A PART OF SECTION 17, T 1 N, R 70 W
OF THE 6TH PM COUNTY OF BOULDER, STATE OF COLORADO

LEGAL DESCRIPTION

A part of the Southwest Quarter of the Northwest Quarter of Section 17 Township 1 North, Range 70 West, 6th Principal Meridian, described as follows

BEGINNING AT THE WEST QUARTER CORNER OF SAID SECTION 17
Thence N 89°38'05" E, a distance of 646.48 feet
Thence N 0°21'55" W, a distance of 35.00 feet
Thence N 54°38'11" E, a distance of 120.03 feet
Thence Northwesterly 768.07 feet along the arc of a curve to the left said curve having a radius of 2799.50 feet, a delta angle of 15°43'11" and being subtented by a chord that bears N 43°13'25" W 765.67 feet
Thence N 51°05'00" W, a distance of 214.40 feet
Thence S 38°55'52" W, a distance of 88.33 feet
Thence S 0°12'00" E, a distance of 732.50 feet
to the POINT OF BEGINNING

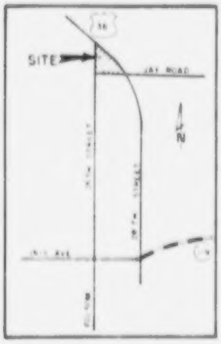
Area = 8.54 acres more or less

NOTES

1 o PINS SET BY DREXEL BARRELL AND CO L.S. 17664

2 SITE IS NOT WITHIN 100 YEAR FLOOD PLAIN FOR FOUR MILE CREEK

1 ● PINS SET BY ROBERT ORTHMAN L.S. 15315



VICINITY MAP
1 : 2000

MAYOR'S CERTIFICATE

THIS IS TO CERTIFY THAT THE CITY OF BOULDER, COLORADO ADOPTS AND APPROVES THE WITHIN PLAT AND ACCEPTS THE DEDICATIONS HEREON MADE

____
MAYOR

____
DIRECTOR OF FINANCE AND RECORD
EX-OFFICIO CITY CLERK

OWNER'S SIGNATURE

FOR APPROVAL OF ARBOR GLEN SUBDIVISION AND CONDITIONS WHICH APPLY THERE TO

BY ________________________ ________________
M.L. MITCHELL CONSTRUCTION DATE

STATE OF COLORADO)
) SS
COUNTY OF BOULDER)

THE FOREGOING INSTRUMENT WAS ACKNOWLEDGED BEFORE ME THIS
______________ DAY OF ____________ 19________
BY __________________________

MY COMMISSION EXPIRES ________________
WITNESS MY HAND AND OFFICIAL SEAL

____
NOTARY PUBLIC
____
____
ADDRESS

DEDICATION

THE UNDERSIGNED BEING THE OWNER OF THE REAL PROPERTY LEGALLY DESCRIBED HEREON HAS CAUSED SAID REAL PROPERTY TO BE LAID OUT AS PER THE DRAWINGS HEREON CONTAINED AND SURVEYED AS ARBOR GLEN SUBDIVISION AND DOES HEREBY SET APART AND DEDICATE TO THE CITY OF BOULDER THAT PORTION OF SAID REAL PROPERTY DESIGNATED FOR STREETS, ROADS, AND AVENUES AND DRIVES AS SHOWN ON THE ACCOMPANYING PLAT FOR THE PUBLIC USE THEREOF FOREVER AND DO FURTHER DEDICATE TO THE CITY OF BOULDER FOR THEIR USE AND THE USE OF ALL MUNICIPALLY OWNED, PERMITTED, AND/OR MUNICIPALLY FRANCHISED UTILITIES AND SERVICES THOSE PORTIONS OF SAID REAL PROPERTY WHICH ARE SO DESIGNATED AS EASEMENTS AND RIGHTS-OF-WAY FOR THE CONSTRUCTION, INSTALLATION, OPERATION, MAINTENANCE, REPAIR, AND REPLACEMENT FOR ALL SERVICES, INCLUDING WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, TELEPHONE AND ELECTRIC LINES, WORKS, POLES, AND UNDERGROUND CABLES, GAS PIPELINES, WATER PIPELINES, SANITARY SEWER LINES, STREET LIGHTS, CULVERTS, HYDRANTS, DRAINAGE DITCHES AND DRAINS AND ALL APPURTENANCES THEREOF. IT BEING EXPRESSLY UNDERSTOOD AND AGREED BY THE UNDERSIGNED THAT ALL EXPENSES AND COSTS INVOLVED IN CONSTRUCTING AND INSTALLING SANITARY SEWER WORKS AND LINES, GAS SERVICE LINES, ELECTRICAL SERVICE WORKS AND LINES, STORM SEWERS AND DRAINS, STREET LIGHTING, GRADING AND LANDSCAPING, CURBS, GUTTERS, STREET PAVEMENT, SIDEWALKS AND OTHER SUCH UTILITIES AND SERVICES SHALL BE GUARANTEED AND PAID FOR BY THE SUBDIVIDER OR ARRANGEMENTS MADE BY THE SUBDIVIDER THEREFORE WHICH ARE APPROVED BY THE CITY OF BOULDER, AND SUCH SUMS SHALL NOT BE PAID BY THE CITY OF BOULDER, COLORADO, AND THAT ANY ITEM SO CONSTRUCTED OR INSTALLED WHEN ACCEPTED BY THE CITY OF BOULDER, EXCEPT ITEMS OWNED BY MUNICIPALLY FRANCHISED UTILITIES WHICH ITEMS, WHEN CONSTRUCTED OR INSTALLED, SHALL REMAIN THE PROPERTY OF THE CITY

APPROVED

____
PUBLIC SERVICE COMPANY
OF COLORADO

____
CITY OF BOULDER — DIRECTOR OF
PUBLIC WORKS/PUBLIC UTILITIES

____
MOUNTAIN STATES TELEPHONE

____
CITY OF BOULDER — DIRECTOR OF
PLANNING AND COMMUNITY DEVELOPMENT

____
CITY OF BOULDER — DIRECTOR OF
REAL ESTATE OPEN SPACE

SURVEYOR'S CERTIFICATE

I, ROBERT ORTHMAN DO HEREBY CERTIFY THAT THE SURVEY OF THE BOUNDARY OF ARBOR GLEN SUBDIVISION WAS MADE UNDER MY SUPERVISION AND THE ACCOMPANYING PLAT ACCURATELY REPRESENTS SAID SURVEY AND THAT I HAVE COMPLIED IN ALL RESPECTS WITH COLORADO REVISED STATUTES, CHAPTER 51, ARTICLE 2, (1963 AS AMENDED IN 1967)

____________________________ NO ___15315___
REGISTERED LAND SURVEYOR

BASIS OF BEARING

BEARING BASED ON WEST LINE OF THE SOUTHWEST ¼ of SECTION 17, T 1 N, R 70 W, 6 TH PM AS BEARING S 00°12'00" E

CLERK AND RECORDER'S CERTIFICATE

STATE OF COLORADO)
) SS
COUNTY OF BOULDER)

I HEREBY CERTIFY THAT THIS PLAT WAS FILED IN MY OFFICE AT ____ O'CLOCK ____M. ON THE ______ DAY OF __________ 19____ AND IS DULY RECORDED IN PLAN FILE __________ FEES PAID __________

____
RECORDER

LENDER'S APPROVAL

____
____
BANK OF BOULDER

BY __________________________

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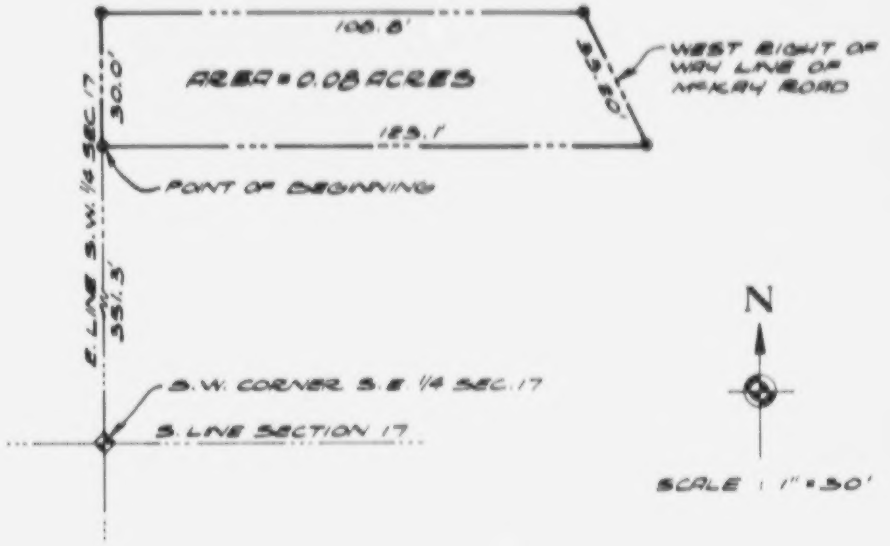
Example of a Legal Description


108.8'
AREA = 0.08 ACRES
30.0'
33.20'
WEST RIGHT OF WAY LINE OF McKAY ROAD
123.1'
E. LINE S.W. 1/4 SEC. 17
POINT OF BEGINNING
351.3'
N
S.W. CORNER S.E. 1/4 SEC. 17
S. LINE SECTION 17
SCALE : 1" = 30'

LEGAL DESCRIPTION:

That part of the Southwest one-quarter of the Southeast one-quarter of Section 17, Township 2 South, Range 67 West of the 6th P.M., County of Adams, State of Colorado, more particularly described as follows:

Commencing at the Southwest corner of the Southeast one-quarter of said Section 17, thence North a distance of 351.3 feet along the East line of the Southwest one-quarter of Section 17, to the point of true beginning; Thence East 123.1 feet more or less, along a line parallel to the South line of Section 17, to the county road; Thence Northwesterly along the right-of-way line of the county road a distance of 33.2 feet more or less; Thence West a distance of 108.8 feet more or less, along a line parallel to the South line of Section 17, to the county road; Thence South a distance of 30.0 feet to the point of beginning, containing 0.08 acres, more or less.

PROPOSED CONSTRUCTION EASEMENT for
SOUTH ADAMS COUNTY
WASTEWATER TREATMENT PLANT

CONSULTING ENGINEERS **SELLARDS & GRIGG, Inc.**
LAKEWOOD, COLORADO

PROJECT 77016-41 JUNE, 1978 D.F.L.

Types of Land Descriptions Used In A Legal Description

Public Land Sectional Description

All that part of the Northeast Quarter of the Northeast Quarter of Section 12, Township 5 North, Range 2 East of the Fifth Principal Meridian, Clarion Township, Walker County, and State of Missouri, described as follows:

Commencing at the Northeast Corner of said Section 12;
Thence on an assumed bearing of South 89°58′40″ West on and along the north line of Section 12 a distance of 825.00 feet to the point of beginning;
Thence South 0°02′20″ West a distance of 721.78 feet;
Thence South 89°58′40″ West a distance of 320.22 feet;
Thence North 31°18′20″ West a distance of 844.57 feet to the said north line of Section 12;
Thence North 89°58′40″ East a distance of 759.55 feet on and along the said north line of Section 12 to the point of beginning.

ALSO known as Lot 5, Block 4, Oak Hills Subdivision, Walker County, Missouri.

Lot and Block Description

Metes and Bounds Description

PLATS AND SUBDIVISIONS
UNIT VII

ASSIGNMENT SHEET #1 — LAYOUT A BOUNDARY SURVEY FROM A LEGAL DESCRIPTION

Directions: You will be given a written legal description from which you will layout the boundary survey. Study the following example prior to beginning your assigned problem.

Example:

Facts: The southwesterly line of this Lot 15 is 235.00 feet (77.10m) long and is also on the northeasterly line of Wood Street and bears S 68° 00′ E. The northwesterly line of this lot is 184.00 feet (60.37m) long and bears N 35° 00′ E. The southeasterly line of the lot is 216.00 feet (70.87m) long and bears S 20° 00′ W. The lot will draft onto a letterhead size sheet using a 1″ = 30′ scale.

Description:

That portion of Lot 15 of Fred Macrae's Tract in Calcasieu Parish, Louisiana, as per map filed in the office of Public Records described by the following courses:

1 — Beginning at a point on the northeast line of Wood Street S 68°00′ E 22.40 feet (7.35m) from the most westerly corner of said Lot,
2 — N 63°20′ E 38.50 feet (12.63m),
3 — N 24°30′ E 47.42 feet (15.56m),
4 — S 87°25′ E 87.86 feet (28.83m),
5 — N 19°20′ E 35.64 feet (11.69m),
6 — S 68°00′ E 78.83 feet (25.86m),
7 — S 24°00′ W 141.15 feet (46.31m) to Wood Street,
8 — N 68°00′ W 182.62 feet (59.91m) along Wood Street to the point of beginning.

* * *

When a course ties to a point, a line or a monument, etc., that then is the controlling factor and if the tie is to a line only, then the distance must be given, while if the tie is to a point, then both the distance and bearing of the line preceding it must be given to the position of that point.

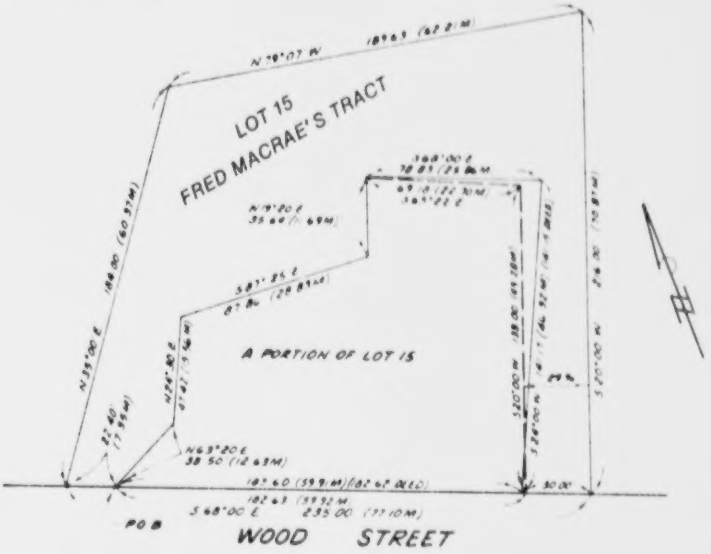
If courses 6 and 7 were changed to read:

6 — S 68°00′ E 78.83 feet (25.86m) to a point on a line parallel with and 29.96 feet (9.83m) northwesterly from the southeasterly line of said Lot which point is N 20°00′ E 138.00 feet (45.28m) from the northeasterly line of Wood Street,
7 — S 20°00′ W 138.00 feet (45.28m) to Wood Street,

draw the additional lines necessary to show their positions with heavy dash lines.

ASSIGNMENT SHEET #1

Drafted layout of example:


LOT 15
FRED MACRAE'S TRACT
A PORTION OF LOT 15
N 63°20' E
38.50 (12.63M)
S 68°00' E
235.00
30.00
POB
WOOD STREET

Directions: Take the following description and draw a map of the "Adams Property."

1. Layout on "D" size vellum.
2. Scale: 1" = 30'.
3. Finalize with ink on polyester film.
4. Hand letter dimensions and notes.
5. Use mechanical or transfer lettering for the title information.
6. Place north arrow with scale and scale bar.
7. Place ½" border all around.

   (NOTE: Refer to Unit VI, "Mapping Drafting Procedures," for a guide to final drafting of this map.)

ASSIGNMENT SHEET #1

ADAMS PROPERTY
TRACT 1

A tract of land located in the SW¹/₄ of the NW¹/₄ of Section 21, T1S, R70W of the 6th P.M., County of Denver, State of Colorado, described as follows:

Commencing at the W¹/₄ Corner of said Section 21, from which the Northwest Corner of said Section 21 bears N00°03′50″W, thence N62°18′10″E, 526.68 feet to the most Southerly Corner of that tract of land conveyed to Robert W. Adams and Alice C. Adams as described in Warranty Deed recorded on Film 518 as Reception No. 769196 of the records of Denver County, Colorado and the TRUE POINT OF BEGINNING;

Thence N13°18′50″W, 323.80 feet along the Southwesterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence N31°21′10″E, 169.74 feet along the Northwesterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence N77°42′10″E, 148.83 feet along the Northwesterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence S13°09′50″E, 690.46 feet to the Northwesterly right-of-way line of Colorado State Highway No. 398;

Thence S60°50′10″W, 140.00 feet along the Northwesterly right-of-way line of said Colorado State Highway No. 398 to the most Southerly Corner of that tract of land conveyed to Robert W. Adams and Alice C. Adams as described in Warranty Deed recorded on Film 598 as Reception No. 842097 of the records of Denver County, Colorado;

Thence N13°09′50″W, 324.43 feet along the Southwesterly line of that tract of land as described on said Film 598 as Reception No. 842097 to the Southeasterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence S60°50′10″W, 137.73 feet along the Southeasterly line of that tract of land as described on said Film 518 as Reception No. 769196 to the TRUE POINT OF BEGINNING.

Area = 3.330 acres, more or less.

PLATS AND SUBDIVISIONS
UNIT VII

ASSIGNMENT SHEET #2 — REDUCE FIELD NOTES AND PLOT A SIMPLE BOUNDARY SURVEY

Property Traverse

Directions: Given the attached field survey notes, calculate the bearing of each property line, the coordinates for each corner, and the area of the parcel. Assume coordinates of 10,000.00, 10,000.00 for point "A". Check to make sure that the sum of the "x" and "y" coordinates on either side of the parcel are equal. Prepare a working drawing of this parcel on 22"×34" reproducible paper.

ASSIGNMENT SHEET #2

BOUNDARY SURVEY

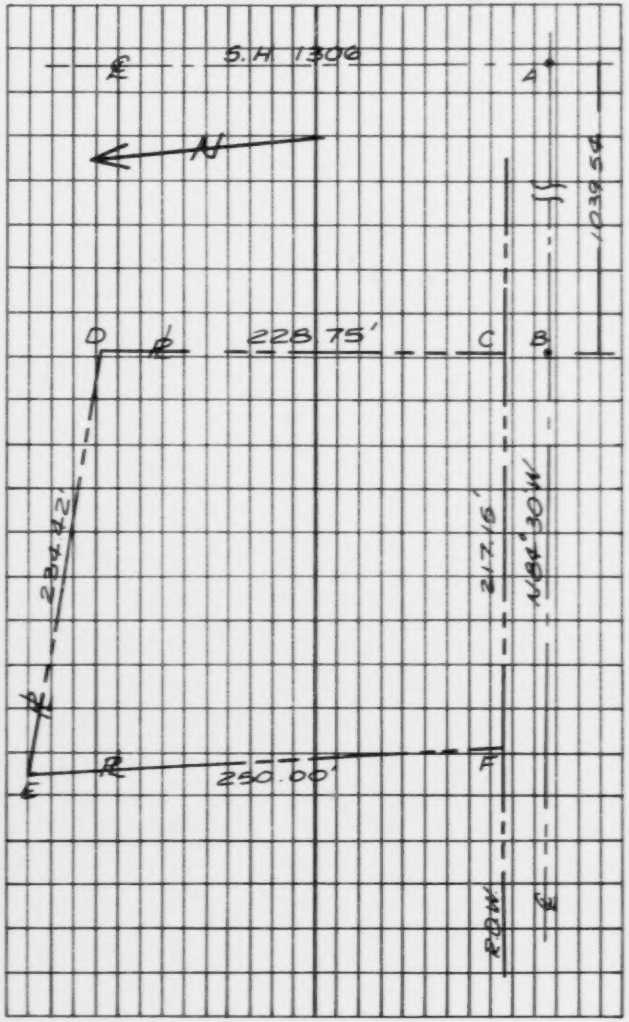
COSGROVE PROPERTY
RTE G1D
S.H. 7306

8-22-78

⊼ J. JONES
📖 B. BROWN
✏ R. SMITH

ASSIGNMENT SHEET #2

⊼	BS	FS	∡	DIST.	NOTES
B	A	C	270°00'00"	BC 33.00'	AB 1039.54'
		D	270°00'00"	CD 228.75'	
D	B	E	95°04'10"	DE 234.42'	
E	D	F	81°10'50"	EF 250.00'	
F	E	C	93°45'00"	FC 217.15'	
C	F	D	90°00'00"		


℄
S.H. 1306
A
N
1039.54
D
228.75'
C
B
234.42'
217.16'
N84°30'W
E
250.00'
F
R.O.W.
℄

PLATS AND SUBDIVISIONS
UNIT VII

ASSIGNMENT SHEET #3 — DEVELOP FROM FIELD NOTES THE PLAT MAP FOR A NINE LOT SUBDIVISION

PART I — Use the attached field notes for each of the nine lots plus road to center line to develop a partial subdivision plat. Follow the guidelines given below:

1. Use a 17×22 in. sheet of vellum.
2. Lay out the 9 lots of the "Last Chance" subdivision at a scale of 1" = 50 feet.
3. Complete the map with *all* necessary peripheral information.

PART II — Planimeter the finished map as outlined in Job Sheet #2 of Unit VI, "Mapping Drafting Procedures." Determine the areas for each individual lot and the total area to the centerline of the roads. Compare your figures obtained with the planimeter to the calculated acres in the field notes. Set up a chart on "A" size vellum with the following information: Lots, Areas, Total Areas of Lots, and Total Areas to Centerline. Hand letter the chart in pencil or ink.

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT +N	RAW LAT − S	RAW DEP + E	RAW DEP − W	ADJ LAT + N	ADJ LAT − S	ADJ DEP + E	ADJ DEP − W	COORD X	COORD Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 1						DMD	2 AREA				
	32.39	S45°03'00"W	-22.88		-22.92		-22.92	+524.41			-22.92	-22.88
	270.18	S44°58'30"E	-191.13		+190.96		+145.12	-27736.79			+168.04	-214.01
	339.28	N62°27'00"E	+156.92		+300.81		+636.89	+99940.78			+468.85	-57.09
	455.82	N77°10'00"W	+101.24		-444.43		+493.27	+49938.65			+24.42	+44.15
	50.454	S28°56'51"W	-44.15		-24.42		+24.42	-1078.14			0	0
			-258.16	+258.16	-491.77	+491.77						
TOTALS												
		DIFF										

2 AREA = 121588.91 SQ.FT.

AREA = 60794.455 SQ FT. =
1.3956486 ACRES

COORDINATES

-22.92(-214.01-0) = +4905.11
168.04(-57.09+22.88) = -5748.85
468.85(44.15+214.01) = +121038.31
24.42(0+57.09) = +1394.14

2 AREAS = 121588.91 SQ. FT.
AREA = 60794.45 SQ FT. = 1.3956 ACRES (MINUS CURB EXCESS = 120.48 SQ.FT.)

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT +N	RAW LAT −S	RAW DEP +E	RAW DEP −W	ADJ LAT +N	ADJ LAT −S	ADJ DEP +E	ADJ DEP −W	COORD X	COORD Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+	0	0
	LOT 2						DMD		2 AREA			
	148.81	N62°27'00"E	+68.83		+131.94		+131.94		+9081.43		+68.83	+131.94
	270.18	N44°58'30"W	+191.13		−190.96		+72.92		+13937.20		+259.96	−59.02
	163.81	S45°03'00"W	−115.73		−115.93		−233.97		+27077.35		+144.23	−174.95
	226.75	S50°30'00"E	−144.23		+174.97		−174.93		+25230.15		0	0.02
			+259.96	−259.96	+306.91	−306.89						
					+0.02							
TOTALS												
		DIFF										

2 AREA = 75326.13
AREA = 37663.065 SQ. FT
= 0.864625 ACRES

COORDINATES

2 AREA = 0(68.83 − 144.23) = 0
131.94(259.96 − 0) = +34299.122
− 59.02(144.23 − 68.83) = −4450.108
− 174.95(0 − 259.96) = 45480.002

2 AREA = 75329.016

AREA = 37664.508 SQ. FT.
= 0.8646581 ACRES

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT +N	RAW LAT - S	RAW DEP + E	RAW DEP - W	ADJ LAT + N	ADJ LAT - S	ADJ DEP + E	ADJ DEP - W	COORD X	COORD Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 3						DMD	2 AREA				
	170.88	S 57°29'47"E	-91.82		+144.11		+144.11	-13232.18			+144.11	-91.82
	165.02	N62°27'00"E	+76.33		+146.31		+434.53	+33167.67			+290.42	-15.49
	226.75	N 50°30'00"W	+144.23		-174.97		+405.87	+58538.63			+115.45	+128.74
	130.47	S45°03'00"W	-92.18		-92.34		+138.56	-12772.46			+23.11	+36.56
	43.25	S 32°17'51"W	-36.56		-23.11		23.11	-844.90			0	0
			-220.56,	+220.56	-290.42,	+290.42	2 AREA = 64856.76					

AREA = 32428.38 SQ. FT. = 0.7444531 ACRES

0.744 ACRES + CURVE (70.02 SQ FT.)

0.746 ACRES

COORDINATES

144.11(-15.49-0) = -2232.26

29042(128.74+91.82) = +64055.04

115.45(36.56+15.49) = +6009.17

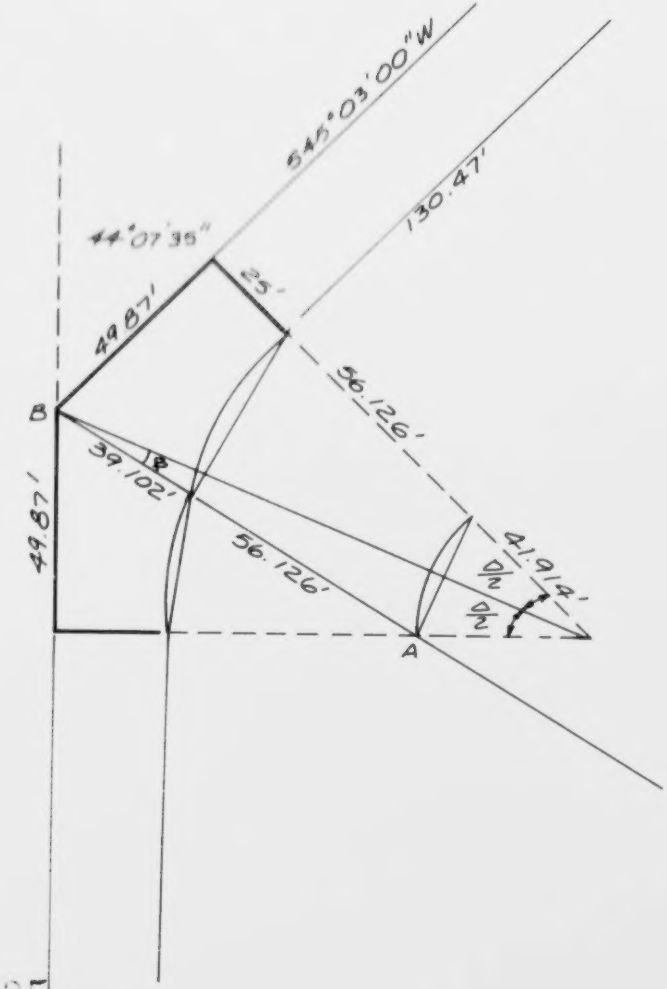
23.11(0-128.74) = -2975.18

2 AREA = 64856.768

AREA = 32428.384 SQ. FT. = 0.7444532 ACRES

TOTALS		DIFF				

ASSIGNMENT SHEET #3


S45°03'00"W
130.47'
44°07'35"
25'
49.87'
B
56.126'
39.102'
β
49.87'
56.126'
41.914'
Δ/2
Δ/2
A

$\beta = 9.51681°$

$\frac{\Delta}{2} = 22.063194°$

$\alpha = 148.42°$

BISECTOR = 132.762'

SHORT CHORD = $\frac{\sin 44°07'35''}{SC} = \frac{\sin 67.93681°}{41.914'}$

$SC = 31.488'$

$\frac{1}{2} SC = 15.744'$

LOT 3

CURVE DATA

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT +N	RAW LAT – S	RAW DEP + E	RAW DEP – W	ADJ LAT + N	ADJ LAT – S	ADJ DEP + E	ADJ DEP – W	COORD X	COORD Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 4						DMD	2 AREA				
	244.78	S00°55'25"W		-224.75		-3.62	-3.62	+813.60			-3.62	-224.75
	151.31	S89°01'30"E		-2.57	+151.29		+144.05	-370.21			+147.67	-227.32
	166.78	N00°43'00"E	+166.77		+2.09		+297.43	+49602.40			+149.76	-60.55
	170.88	N57°29'47"W	+91.82			-144.11	+155.41	+14269.75			+5.65	+31.27
	31.776	S10°14'31"W		-31.27		-5.65	+5.65	-176.68			0	0
			-258.59	+258.59	-153.38	+153.38						
TOTALS		**DIFF**										

2 AREA = 64138.86 SQ.FT.

AREA = 32069.43 SQ.FT. = 0.7362128 ACRES

COORDINATES

-3.62(-227.32-0) = + 822.90
147.67(-60.55+224.75) = +24247.41
149.76(31.27+227.32) = +38726.44
5.65(0+60.55) = + 342.11
2 AREA = 64138.857 SQ.FT.
AREA = 32069.428 SQ.FT. = 0.7362127 ACRES (MINUS SE CORNER
CURB-AREA = 100.09 SQ.FT. PLUS CORNER
AREA A △ 44°07'35" = +43.20 SQ.FT. -56.89 SQ.FT.

STA	LENGTH (FT)	BEARING	RAW LAT		RAW DEP		ADJ LAT		ADJ DEP		COORD	
			+N	−S	+E	−W	+N	−S	+E	−W	X	Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 5						DMD	2AREA				
	155.30	S89°01'30"E	−2.64		+155.28		+155.28	−409.94			+155.28	−2.64
	245.43	N01°36'30W	+245.33			−6.89	+303.67	+74499.36			+148.39	+242.69
	165.02	S62°27'00"W	−76.33			−146.31	+150.47	−11485.38			+2.08	+166.36
	166.78	S00°43'00"W	−166.77			−2.09	+2.07	−345.21			−0.01	−0.41
			−245.74,	+245.33	−155.29,	155.28						
TOTALS		DIFF										

2 AREA = 62258.827 SQ. FT.

AREA = 31129.413 SQ. FT. = 0.7146329 ACRES

COORDINATES

155.28 (242.69 − 0) = + 37684.90

148.39 (166.36 + 2.64) = + 25077.91

2.08 (−0.41 − 242.69) = − 505.65

−0.01 (0 − 166.36) = + 1.66

2 AREA = 62258.823 SQ. FT.

AREA = 31129.411 SQ. FT. = 0.7146329 ACRES

ASSIGNMENT SHEET #3

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW	LAT	RAW	DEP	ADJ	LAT	ADJ	DEP	COORD	
			+N	− S	+ E	− W	+ N	− S	+ E	− W	X	Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 6						DMD	2AREA				
	152.78	S89°01'30"E	−2.60		+152.76		+152.76	−397.18			+152.76	−2.60
	317.97	N05°00'00"W	+316.76		−27.71		+277.81	+87999.10			125.05	314.16
	148.81	S62°27'00"W	−68.83		−131.94		+118.16	−8162.95			−6.89	245.33
	245.43	S01°36'30"E	−245.33		+6.89		−6.89	1690.32			0	0
			−316.76,	+316.76	−159.65,	159.65	2 AREA = 81159.29					
							AREA = 40579.645 SQ.FT. = 0.9315804 ACRES					
TOTALS		DIFF										

COORDINATES

152.76 (314.16 − 0) = +47991.08

125.05 (245.33 + 2.60) = +31003.65

−6.89 (0 − 314.16) = +2164.56

0 (−2.60 − 245.33) = 0

2 AREA = 81159.29

AREA = 40579.645 SQ. FT. = 0.9315804 ACRES

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT +N	RAW LAT − S	RAW DEP + E	RAW DEP − W	ADJ LAT + N	ADJ LAT − S	ADJ DEP + E	ADJ DEP − W	COORD X	COORD Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 7						DMD	2 AREA				
	148.42	S89°01'30"E	-2.53		+148.40		+148.40	-375.45			+148.40	-2.53
	374.42	N14°21'30"W	+362.72		-92.85		+203.95	+73976	74		+55.55	360.19
	93.91	S62°27'00"W	-43.44		-83.26		+27.84	-1209.37			-27.71	316.75
	317.97	S05°00'00"E	-316.76		+27.71		-27.71	8777.42			0	-0.01
			-362.73	+362.72	-176.11	+176.11	2 AREA = 81169.34					
							AREA = 40584.67 SQ.FT. = 0.9316938 ACRES					
TOTALS		DIFF										

COORDINATES

148.90 (360.19 + .01) = + 53453.68

55.55 (316.75 + 2.53) = + 17736.00

-27.71 (-.01 - 360.19) = + 9981.14

0 (-2.53 - 316.75) = 0

2 AREA = 81170.82

AREA = 40585.41 SQ. FT. = 0.9317128 ACRES

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT		RAW DEP		ADJ LAT		ADJ DEP		COORD	
			+ N	− S	+ E	− W	+ N	− S	+ E	− W	X	Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 8						DMD	2 AREA				
	40.61	S89°01'30"E	−0.69		+40.60		+40.60	−28.014			40.60	−0.69
	152.58	N35°06'30"E	+124.82		+87.75		+168.95	+21088.339			128.35	124.13
	314.01	N25°45'30"W	+282.81		−136.46		+120.24	+34005.074			−8.11	406.94
	95.75	S62°27'00"W	−44.29		−84.89		−101.11	+4478.16			−93.00	362.65
	374.42	S14°21'30"E	−362.72		+92.85		−93.15	+33787.368			−0.15	−0.07
			−407.70,	+407.63	−221.35	+221.20						

2 AREA = 93330.927

AREA = 46665.463 SQ.FT. = 1.0712916 ACRES

COORDINATES

40.60 (124.13 − 0.07) = +5036.84

128.35 (406.94 + .69) = +52319.31

−8.11 (362.65 − 124.13) = −1934.40

−93.00 (−.07 − 406.94) = +37851.93

−0.15 (−0.69 − 362.65) = + 54.50

2 AREA = 93328.18 SQ.FT.

AREA = 46664.09 SQ.FT. = 1.0712601 ACRES

CURVE − 250.46 SQ.FT.

CUL-DE-SAC − 741.96 SQ.FT. (APPROX.)

992.42 SQ. FT

TOTALS

DIFF

STA	LENGTH (FT)	BEARING	RAW	LAT	RAW	DEP	ADJ	LAT	ADJ	DEP	COORD	
			+ N	− S	+ E	− W	+ N	− S	+ E	− W	X	Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOT 9						DMD	2 AREA				
	149.56	N64°13'30"E	+65.03		+134.68		134.68	8758.24			65.03	134.68
	347.16	N25°45'25"W	+312.67			−150.86	118.50	37051.40			377.70	−16.18
	149.62	S62°27'00"W		−69.20		−132.65	−165.01	+11418.69			308.50	−148.83
	342.54	S25°45'30"E		−308.50	+148.86		−148.80	+45904.80			0	0
			+ 377.70	−377.70	+283.54	−283.51						
						+0.03						
TOTALS												
		DIFF										

2 AREA = 11513.85
= 5756.925 SQ.FT.
1.1838 ACRES

COORDINATES

0(65.03 − 308.50) = 0
134.68(377.70 − 0) = 30868.64
−16.18(308.50 − 65.03) = −3939.34
−148.83(0 − 377.70) = 56213.09

51571.19 SQ.FT. − 1590.43 (COL-DE-SAC) = 1.1839 ACRES

ASSIGNMENT SHEET #3

CD-475

ASSIGNMENT SHEET #3

STA	LENGTH (FT)	BEARING	RAW LAT +N	RAW LAT − S	RAW DEP + E	RAW DEP − W	ADJ LAT + N	ADJ LAT − S	ADJ DEP + E	ADJ DEP − W	COORD X	COORD Y
	+	+	L COS BE	L COS BE	L SIN BE	L SIN BE	+	+	+	+		
	LOTS 1 - 9 PLUS ROAD TO CENTER LINE						DMD	ΣAREA				
	418.08	S45°03'00"W		-295.37		-295.88	-295.88	+87394.075			-295.88	-295.37
	299.65	S00°55'25W		-299.61		- 4.83	-596.59	+178744.32			-300.71	-594.98
	686.38	S89°01'30"E		- 11.68		+686.28	+84.86	-991.16			+385.57	-606.66
	152.58	N35°06'30"E		+124.82		+87.75	+858.89	+107206.64			+473.32	-481.84
	149.56	N64°13'30"E		+65.03		+134.68	+1081.32	+ 70318.239			+608.00	-416.81
	347.16	N25°45'25"W		+312.67		-150.86	+1065.14	+333037.32			+457.14	-104.14
	468.85	N77°10'00"W		+104.14		-457.14	+457.14	+47606.56			0	0
			-606.66	+606.66	-908.71	+908.71	Σ AREA = 823315.97					
							AREA = 411657.98 SQ.FT. = 9.4503668 ACRES					
TOTALS		DIFF										

-295.88(-594.98-0) + 300.71 (-606.66 + 295.37) + 385.57 (-481.84 + 594.98) + 473.32 (-416.81 + 606.66)

+608.00 (-140.14 + 481.84) + 457.14 (0 + 416.81) = +176042.68 + 93608.015 + 43623.389 + 89859.802 +

229641.6 + 190540.52 = Σ AREA = 823315.99

AREA = 411657.99 SQ.FT. = 9.450 ACRES

PLATS AND SUBDIVISIONS
UNIT VII

ASSIGNMENT SHEET #4 — REDRAW TO SCALE A COMPLETE FINAL PLAT OF A 36 LOT SUBDIVISION

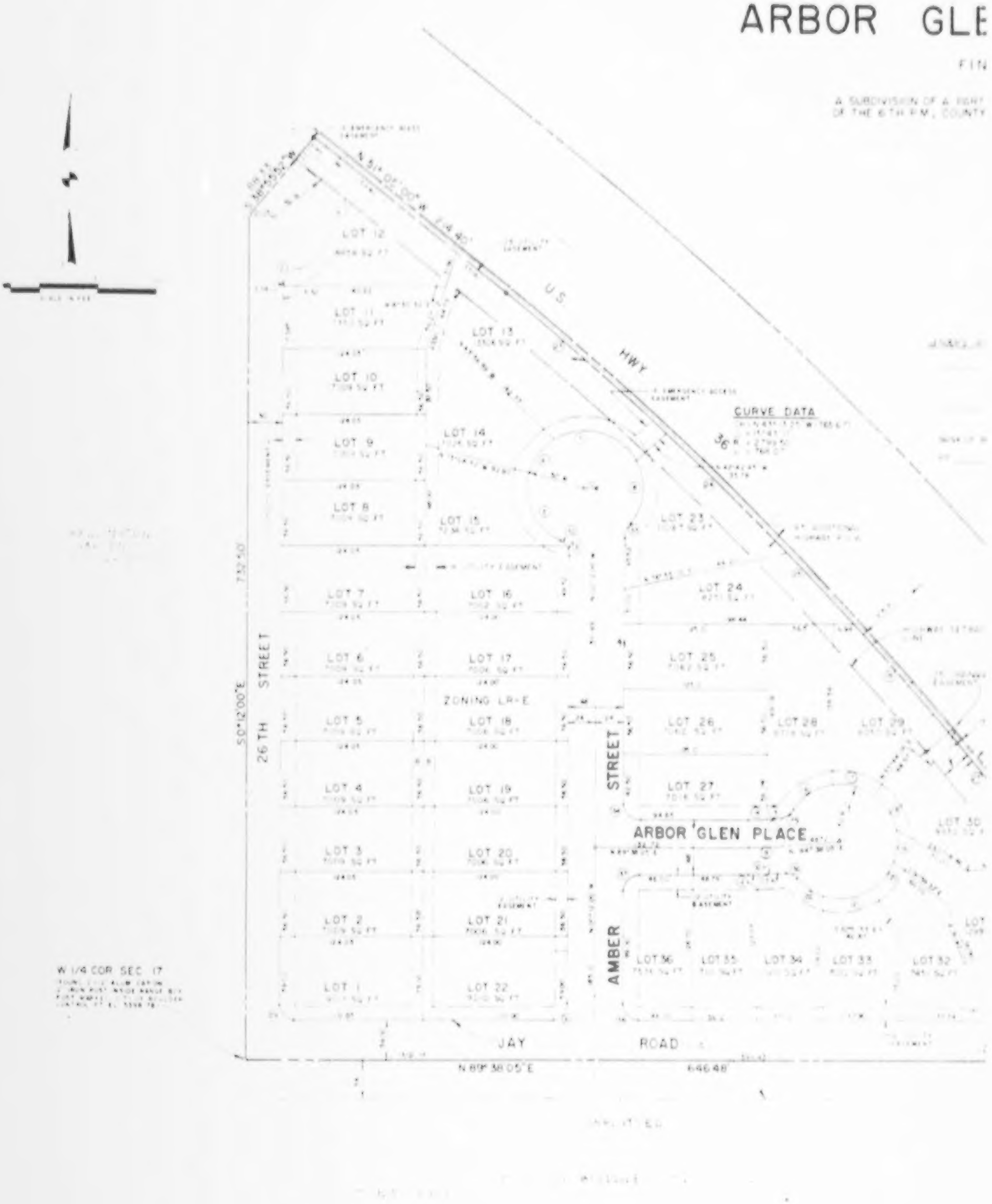
Given: A copy of a complete final plat for a 36 lot subdivision.

Directions:

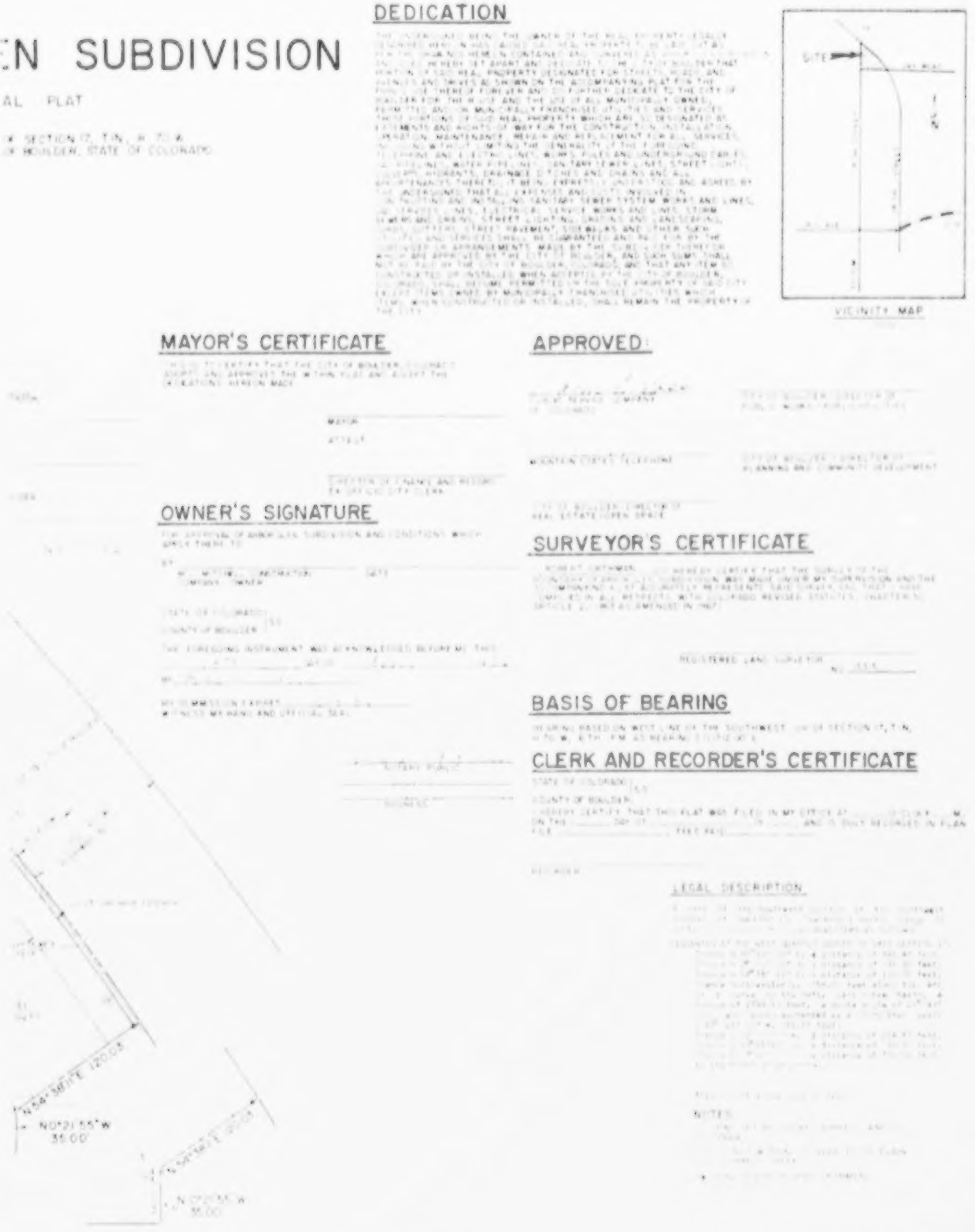
1. Use drawing scale 1" = 50'.
2. Layout the boundary survey. Final draft in ink on polyester film.
3. Dimension using mechanical lettering for boundary information.
4. Type or use plastic transfer film for:
    a. Certificate information
    b. Legal description
    c. Dedication
5. Use mechanical lettering for the title information and bearing chart.

(NOTE: Refer to Unit VI, "Mapping Drafting Procedures," for additional information on setting up your map.)

ASSIGNMENT SHEET #4


ARBOR GLE
FIN
A SUBDIVISION OF A PART
OF THE 6TH P.M., COUNTY
U.S. HWY
CURVE DATA
LOT 1
LOT 2
LOT 3
LOT 4
LOT 5
LOT 6
LOT 7
LOT 8
LOT 9
LOT 10
LOT 11
LOT 12
LOT 13
LOT 14
LOT 15
LOT 16
LOT 17
LOT 18
LOT 19
LOT 20
LOT 21
LOT 22
LOT 23
LOT 24
LOT 25
LOT 26
LOT 27
LOT 28
LOT 29
LOT 30
LOT 32
LOT 33
LOT 34
LOT 35
LOT 36
ZONING LR-E
26TH STREET
S0°12'00"E
732.50
STREET
AMBER
ARBOR GLEN PLACE
JAY ROAD
N 89°38'05"E
646.48
W 1/4 COR SEC 17
S 51°02'00"E
214.40

ASSIGNMENT SHEET #4



:N SUBDIVISION

DEDICATION

VICINITY MAP

MAYOR'S CERTIFICATE

APPROVED:

OWNER'S SIGNATURE

SURVEYOR'S CERTIFICATE

REGISTERED LAND SURVEYOR

BASIS OF BEARING

CLERK AND RECORDER'S CERTIFICATE

STATE OF COLORADO

COUNTY OF BOULDER

LEGAL DESCRIPTION

SITE
N54°58'E 120.00'
N0°21'55"W
35.00'

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ASSIGNMENT SHEET #4

NO.	CHORD	Δ	R	L	E	T
1	N 43°13′25″ W (765.67)	15°43′11″	2799.5	768.07	26.55	386.46
2	N 34°12′38″ E (15.89)	69°09′05″	14.0	16.90	3.00	9.65
3	—— –	——	——	——	——	——
4	N 00°38′55″ W (93.63)	138°52′09″	50.0	121.19	92.34	133.27
5	N 24°42′06″ W (63.68)	79°06′28″	50.0	69.03	14.85	41.30
6	N 32°02′28″ E (29.55)	34°22′39″	50.0	30.00	2.34	15.47
7	S 77°36′15″ E (80.04)	106°19′56″	50.0	92.79	33.40	66.75
8	S 8°23′09″ W (54.21)	65°38′53″	50.0	57.29	9.50	32.25
9	N 87°08′05″ E (30.53)	5°00′00″	350.0	30.54	0.33	15.28
10	N 87°15′58″ E (30.91)	4°44′13″	374.0	30.92	0.32	15.47
11	N 87°17′51″ E (26.59)	4°40′27″	326.0	26.59	0.27	13.30
12	N 89°04′55″ E (7.21)	1°06′17″	374.0	7.21	0.02	3.61
13	N 86°42′50″ E (23.71)	3°37′56″	374.0	23.71	0.19	11.86
14	N 88°11′50″ E (16.36)	2°52′29″	326.0	16.36	0.10	8.18
15	N 85°51′36″ E (10.24)	1°47′58″	326.0	10.24	0.04	5.12
16	N 56°16′11″ E (42.59)	50°24′42″	50.0	43.99	5.26	23.53
17	S 76°23′41″ E (37.67)	44°15′34″	50.0	38.62	3.98	20.33
18	S 33°07′57″ E (36.05)	42°15′54″	50.0	36.88	3.60	19.33
19	S 5°17′01″ W (29.71)	34°34′04″	50.0	30.17	2.36	15.56
20	S 39°51′05″ W (29.71)	34°34′04″	50.0	30.17	2.36	15.56
21	S 82°34′51″ W (42.97)	50°53′29″	50.0	44.41	5.37	23.79
22	N 56°52′43″ W (26.04)	30°11′21″	50.0	26.35	1.79	13.49
23	S 49°11′08″ E (185.43)	3°47′45″	2799.5	185.47	1.54	92.77
24	S 45°47′20″ E (146.45)	2°59′51″	2799.5	146.46	0.96	73.25
25	S 43°25′30″ E (84.49)	1°43′46″	2799.5	84.50	0.32	42.25
26	S 41°29′10″ E (105.00)	2°08′56″	2799.5	105.00	0.49	52.50
27	S 38°42′23″ E (166.61)	3°24′38″	2799.5	166.64	1.24	83.34
28	S 36°10′56″ E (80.00)	1°38′15″	2799.5	80.01	0.29	40.01
29	S 45°16′58″ E (19.77)	89°50′05″	14.0	21.95	5.77	13.96
30	N 44°43′03″ W (19.83)	90°09′55″	14.0	22.03	5.83	14.04
31	N 15°18′59″ W (7.22)	29°54′08″	14.0	7.31	0.49	3.74
32	N 47°15′42″ W (8.18)	33°59′17″	14.0	8.30	0.64	4.28
33	S 20°25′20″ W (9.94)	41°34′31″	14.0	10.16	0.97	5.31
34	S 45°16′58″ E (19.77)	89°50′05″	14.0	21.95	5.77	18.96
35	N 58°00′44″ E (12.69)	53°53′48″	14.0	13.17	1.71	7.12
36	N 58°26′36″ W (12.56)	53°19′05″	14.0	13.03	1.67	7.03
37	S 44°43′03″ W (19.83)	90°09′55″	14.0	22.03	5.83	14.04
38	S 45°16′58″ E (19.77)	89°50′05″	14.0	21.95	5.77	13.96

PLATS AND SUBDIVISIONS
UNIT VII

ASSIGNMENT SHEET #5 — RESEARCH THE PLAT INFORMATION FOR YOUR PROPERTY OR A PROPERTY IN YOUR AREA

Directions:

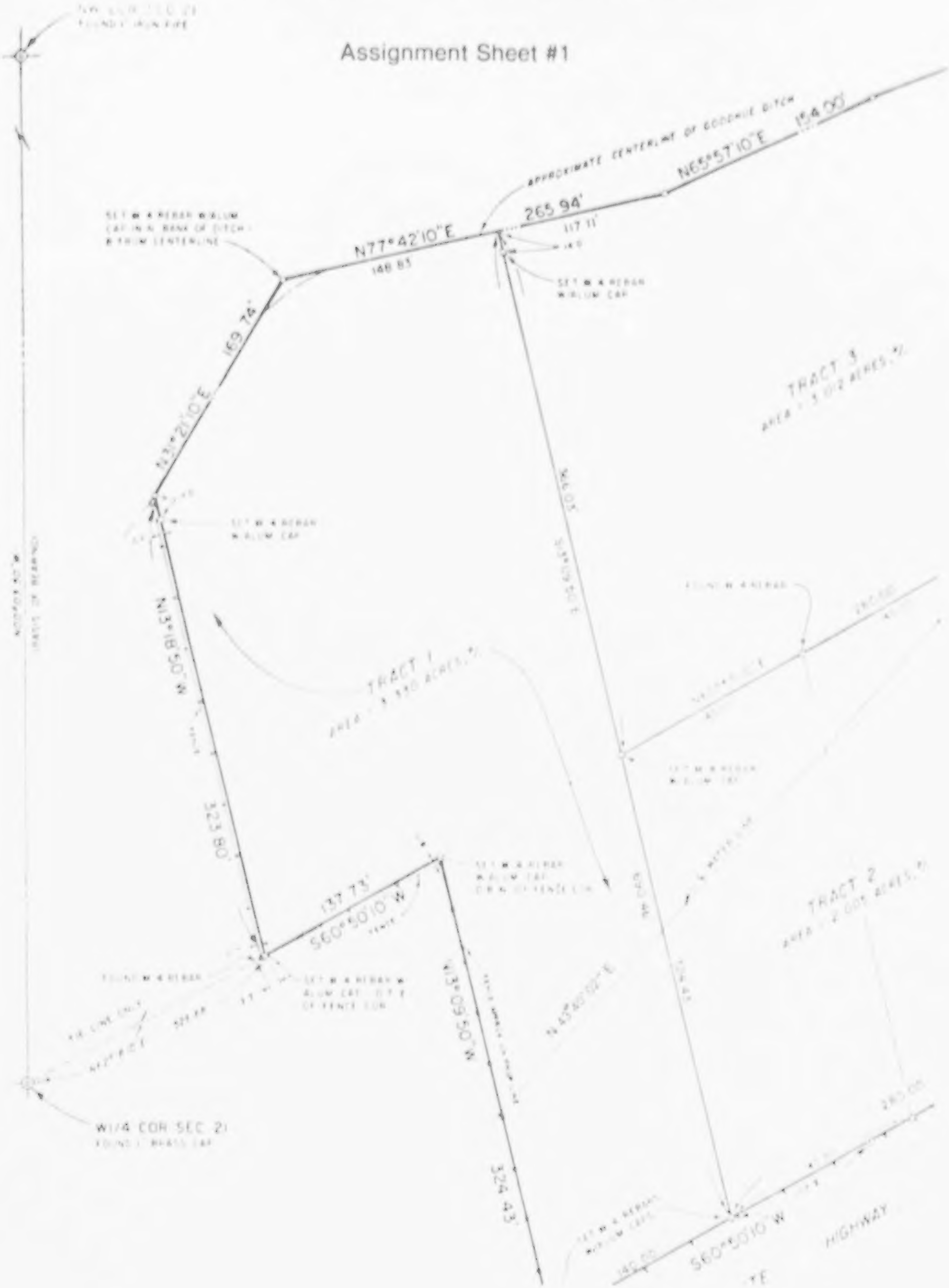
1. Determine the location of the property you want to research.
2. Locate your local Planning Commission.
3. Make an on-site visit and request to see the plat for the property you have chosen.

   (NOTE: Some planning offices will provide you a copy of the final plat.)
4. Record the following information:
   a. City ______________
   b. County (borough or parish) ______________
   c. State ______________
   d. Is the land all or part of a lot or parcel shown on the map? ______________ If so, what is the lot or parcel number, letter, or name? ______________
   e. What is the name or number of the map? ______________
   f. If the map is officially filed or recorded, what is the correct reference file no. ______________ or book ______________ and page ______________?
   g. If the land is part of the Public Lands (that is section land), what is the section number ______________, township ______________, range ______________, and meridian ______________?
   h. If the land is part of a private land grant, what is the correct reference to its map or its creation by book ______________, page ______________?

PLATS AND SUBDIVISIONS
UNIT VII

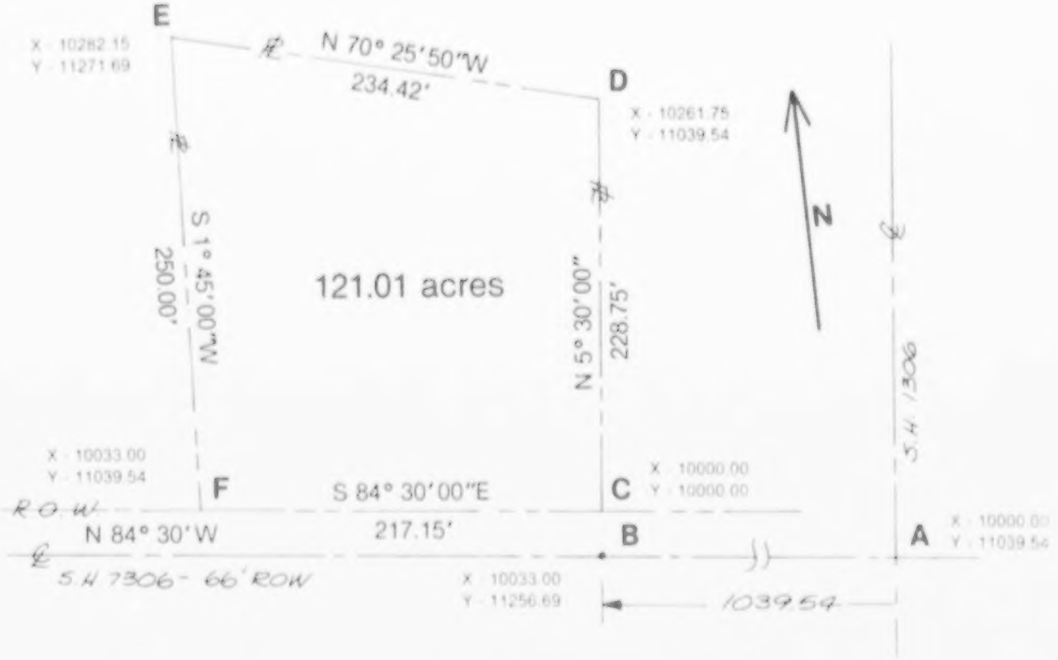
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1


SET W 4 REBAR W/ALUM CAP IN N. BANK OF DITCH 8 FROM CENTERLINE
N77°42'10"E
148.83
APPROXIMATE CENTERLINE OF GOODHUE DITCH
265.94'
117.11'
N65°57'10"E
154.00'
SET W 4 REBAR W/ALUM CAP
169.74'
N33°21'10"E
TRACT 3
AREA = 3.012 ACRES ±
SET W 4 REBAR W/ALUM CAP
N13°18'50"W
TRACT 1
323.80'
137.73'
S60°50'10"W
FOUND W 4 REBAR
W1/4 COR SEC 21
FOUND 1 BRASS CAP
N13°09'50"W
324.43'
N 43°40'02"E
TRACT 2
AREA = 2.005 ACRES ±
285.00
145.00
S60°50'10"W
HIGHWAY

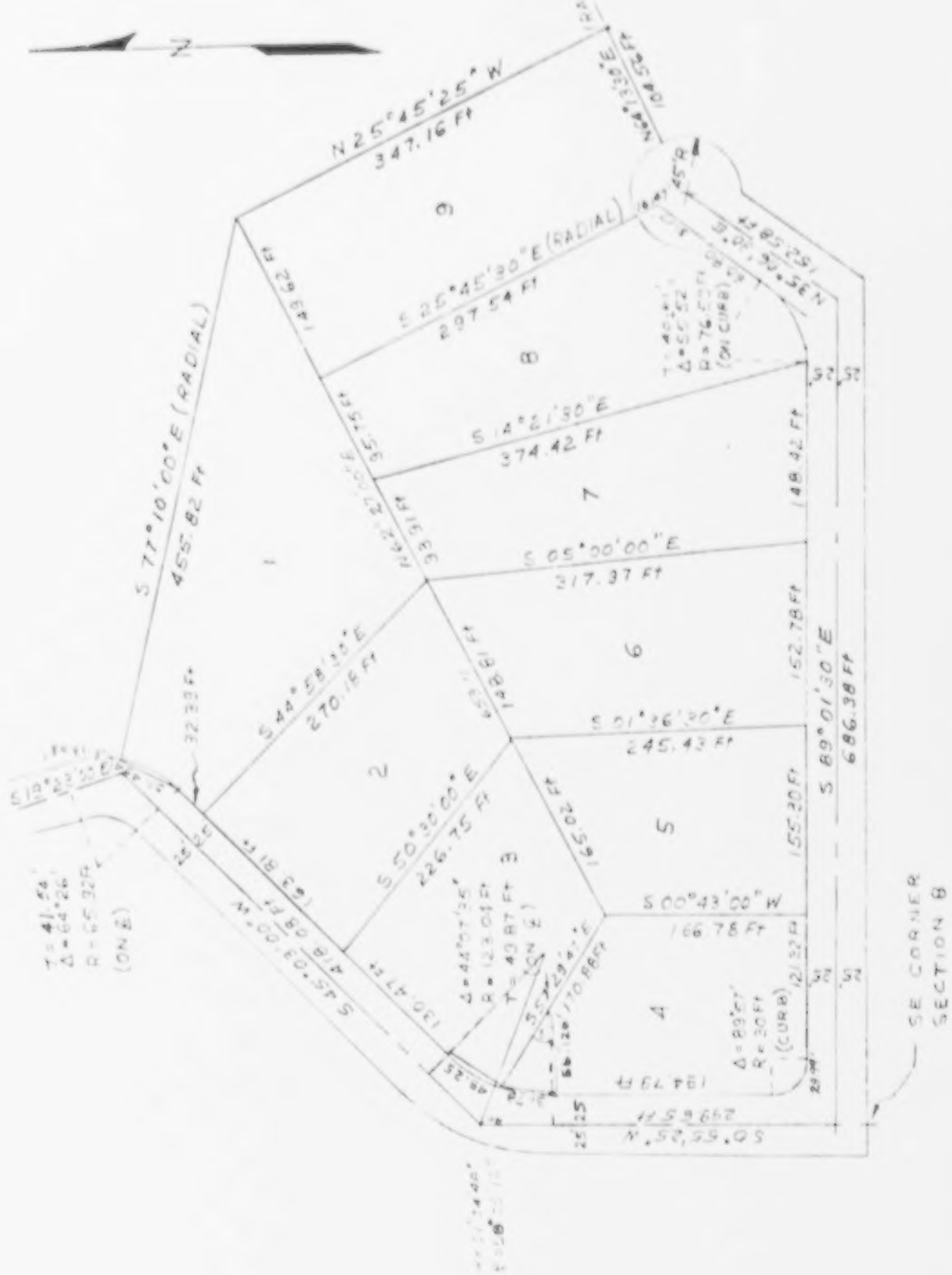
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2


E
X - 10282.15
Y - 11271.69
℄
N 70° 25'50"W
234.42'
D
X - 10261.75
Y - 11039.54
℄
℄
N
℄
S 1° 45'00"W
250.00'
121.01 acres
N 5° 30'00"
228.75'
S.H. 1306
X - 10033.00
Y - 11039.54
F
S 84° 30'00"E
C
X - 10000.00
Y - 10000.00
R.O.W.
N 84° 30'W
217.15'
B
A
X - 10000.00
Y - 11039.54
℄
S.H. 7306 - 66' ROW
X - 10033.00
Y - 11256.69
1039.54

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #3 — Part I


N
N 25°45'25" W
347.16 Ft
S 77°10'00"E (RADIAL)
455.82 Ft
S 25°45'30"E (RADIAL)
297.54 Ft
S 14°21'30"E
374.42 Ft
S 05°00'00"E
317.37 Ft
S 01°36'30"E
245.43 Ft
S 00°43'00" W
166.78 Ft
S 44°58'35"E
270.16 Ft
S 50°30'00"E
226.75 Ft
S 89°01'30"E
686.38 Ft
N 62°27'00"E
149.62 Ft
357.5 Ft
339.31 Ft
148.61 Ft
165.02 Ft
170.86 Ft
148.42 Ft
152.78 Ft
155.20 Ft
121.32 R
184.73 Ft
S 45°03'00" W
130.47 Ft
32.39 Ft
S 19°33'30"E
T = 41.54'
Δ = 64°26'
R = 65.92 R
(ON ℄)
Δ = 44°07'35"
R = 123.04 Ft
T = 49.87 Ft
(ON ℄)
T = 40.47'
Δ = 55°52'
R = 76.00 Ft
(ON CURB)
Δ = 89°01'
R = 30 Ft
(CURB)
45 R
N 8°11'30" E
104.55 Ft
S 26°50'00"E
S 65°55' W
25
25
1
2
3
4
5
6
7
8
9
SE CORNER
SECTION 8

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #3 — Part II

	SQ FT	ACRES
Lot 1	60674	1.393
Lot 2	37665	0.865
Lot 3	32498	0.746
Lot 4	32013	0.735
Lot 5	31129	0.715
Lot 6	40580	0.932
Lot 7	40585	0.932
Lot 8	45672	1.048
Lot 9	49981	1.147

Total area + Area to ℄ 9.450367 acres

Total area of lots 8.513 acres

Assignment Sheet #4 — Evaluated to the satisfaction of the instructor.

Assignment Sheet #5 — Evaluated to the satisfaction of the instructor.

PLATS AND SUBDIVISIONS
UNIT VII

NAME ______________________

TEST

1. Match terms related to plats and subdivisions with the correct definitions.

_____a. An interest or right in land owned by another that entitles its holder to a specific limited use, such as laying a sewer, crossing over property, or putting up power lines

_____b. A survey which creates, marks, defines, retraces, or reestablishes the boundaries and subdivisions of the land

_____c. A public record showing the location, size, and name of owners of various recorded plats in the municipality or county

_____d. A written statement recognized by law as to the definite location of a tract of land by reference to a survey, recorded map, or adjoining property

_____e. A plan containing original ground contours over which contours of the highway, subdivision, or other embankment or excavation to be completed are superimposed on and connected with the original ground contours at the edge of construction limits

_____f. A point on the surface of the earth, determined by the surveying process, which defines an extremity on a boundary of public lands

_____g. The specific data about a corner monument and its accessories which include marks, positions, and physical characteristics

_____h. In ordinary survey usage, a defined reference line for survey measurement

_____i. To place survey data upon a map or plat

_____j. A dead-end street which widens sufficiently at the end to permit an automobile to make a "U" turn

1. Bench mark
2. Cadastral survey
3. Corner
4. Corner description
5. Cul-de-sac
6. Datum line
7. Easement
8. Grade plan
9. Legal description
10. Monument

TEST

_____k. A relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known

_____l. The process of preparing a plat or subdivision according to state and local ordinances

_____m. The component of the new status records, a copy of the master title plat which shows in addition to survey, ownership, and restrictive data, leases, licenses, and permits currently effective

_____n. A physical structure, such as an iron post, marked stone, or tree in place, which marks the location of a corner point established by a cadastral survey

_____o. A map of a subdivision of land usually prepared in accordance with state plat statutes or local subdivision regulations or both

_____p. Either a citizen committee appointed by the chief executive or legislative body to review subdivision plans, or a full- or part-time staff of professional planners hired to carry out continued planning activities, review subdivision plans, conduct studies, etc.

11. Planning commission
12. Plat, subdivision
13. Plat, use
14. Platting
15. Plot
16. Subdivision plot book

2. Define subdivision planning. ____

____

3. Select from the following list the official agents who may regulate subdivision planning by placing an "X" next to the correct agents.

_____a. City council

_____b. Mayor

_____c. Chamber of Commerce Executive Director

_____d. City and county planning commission

_____e. County commissioners

4. List three duties that may be performed by regulatory agents for the subdivision of land.

a. ____

b. ____

c. ____

TEST

5. Arrange in order the following steps in planning a subdivision by placing the correct sequence numbers (1-5) in the appropriate blanks.

_____ a. A tentative plan is developed to show outline of property, proposed title of the subdivision, proposed layout, topographic features, existing easements, legal description, as well as other information

_____ b. The planning office and city engineer are consulted for governing rules and regulations of local planning agencies.

_____ c. After the tentative plan is approved and all changes are made, a final subdivision plat is drawn up, and then has to receive final approval from the appropriate governing agency.

_____ d. A small scale location map is developed to show the relation of the subdivision to the surrounding properties.

_____ e. The tentative map is presented for review to the clerk of the advisory agency such as the planning commission.

6. Complete the following statements concerning the final recordation of a subdivision plat by correctly filling in the blanks.

a. The final plat is considered a legal working document and will be on file at the ______________________________.

b. It is drawn at a scale of ____________.

c. Items required on a final plat include the following: (list at least eight)

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

5) ______________________________

6) ______________________________

7) ______________________________

8) ______________________________

TEST

d. The title sheet will include: (list five)

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

5) ______________________________

e. The final plat may include a grading plan and plan and profiles for ______________.

f. Accuracy of boundary closure varies based on ______________.

7. Select from the following list the individuals who certify and approve the final plat map by placing an "X" next to their names.

______a. Financial institution — Mortgage release

______b. Chief drafter

______c. Private engineer or surveyor

______d. City attorney

______e. Public engineer or surveyor

______f. City agent

______g. State treasurer

______h. Owner

______i. Clerk and recorder

8. Complete the following statements concerning legal descriptions by circling the correct words.

a. Are (**written, oral**) descriptions describing the relationship of a parcel of land to the surrounding surveys.

b. A complete description will begin with the (**smallest, largest**) division and go to the (**smallest, largest**).

TEST

c. A complete description can include all three types of land descriptions:

1) (**Public land sectional system, Metes and bounds**) to identify the point of beginning

2) (**Public land sectional system, Metes and bounds**) to describe the boundary lines

3) Lot and block description can be used as an alternate description.

9. List seven guidelines for drafting a plat.

Example: Show lot corners by small circles

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

10. List two methods for laying out and developing a map.

a. ______________________________

b. ______________________________

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

11. Layout a boundary survey from a legal description. (Assignment Sheet #1)

12. Reduce field notes and plot a simple boundary survey. (Assignment Sheet #2)

13. Develop from field notes the plat map for a nine lot subdivision. (Assignment Sheet #3)

14. Redraw to scale a complete final plat of a 36 lot subdivision. (Assignment Sheet #4)

15. Research the plat information for your property or a property in your area. (Assignment Sheet #5)

PLATS AND SUBDIVISIONS
UNIT VII

ANSWERS TO TEST

1. a. 7
   b. 2
   c. 16
   d. 9
   e. 8
   f. 3
   g. 4
   h. 6
   i. 15
   j. 5
   k. 1
   l. 14
   m. 13
   n. 10
   o. 12
   p. 11

2. The process of dividing urban land into orderly, accurately surveyed parcels

3. a, d, e

4. Any three of the following:
   a. Draw up zoning and building regulations
   b. Establish rules for building height limits, parking facilities, and right-of-way set-back lines
   c. Establish specifications for improvements on (any of the following):
      1) Sewers
      2) Water lines
      3) Sidewalks
      4) Curbs
      5) Gutters
      6) Street paving
   d. Grant permits for sale of new subdivision lots
   e. Establish utility regulations

5. a. 3
   b. 1
   c. 5
   d. 2
   e. 4

6. a. County courthouse
   b. 1" = 100' or larger
   c. Any eight of the following:
      1) Legal description of the property
      2) Property lines, dimensions, and bearings
      3) Direction of north
      4) All roads, existing and proposed
      5) Driveways, patio slabs, parking areas, and walkways
      6) Proposed and existing structures
      7) Location of well and/or water service line, location of wells on adjacent properties
      8) Location of proposed gas and power lines

ANSWERS TO TEST

9) Location of septic tank, drainfield, drainfield replacement area, and/or sewer
10) Dimensions and spacing of soil absorption field or leach lines, if used
11) Location of soil test holes, if used
12) Proposed location of rain drains, footing drains, and method of disposal
13) Ground elevation at lot corners, and street elevation at driveway centerline
14) Slope of ground
15) Proposed elevations of main floor; garage floor; and basement of crawl space
16) Proposed setback from all property lines
17) Utility and drainage easements
18) Natural drainage channels
19) Total acreage
20) Drawing scale
21) Necessary signatures of certification
(NOTE: Requirements for the final plat may vary in your locale.)

d. Any five of the following:
  1) Certification signatures
  2) Caption type description
  3) Basis of bearing
  4) Monument note
  5) Bench mark (if required)
  6) Legend (if required)
  7) Omission of certain signature (if applicable)
  8) Index map of subsequent sheets (if many)
  9) North arrow and scale
  10) Soil test report (if required)
  11) Any special notes

e. Utilities and/or street improvements

f. Value of land

7. a, c, e, f, h, i

8. a. Written
   b. Smallest, largest
   c. 1) Public land sectional system
      2) Metes and bounds

9. Any seven of the following:
   a. A datum line must be established and elevations shown
   b. Use symbols to represent lakes, ponds, rivers, etc.
   c. Indicate the compass orientation of the lot
   d. Show property lines
   e. Show corner elevations above the datum
   f. Show changes in contours by dashed or dotted lines
   g. Show new grade (N.G.) and final grade (F.G.)
   h. Show dimensions from property lines to utility lines
   i. Show any easements
   j. Show all encroachments to the property

ANSWERS TO TEST

- k. Indicate owner and legal description
- l. Show lot number and addition where it is located
- m. Label utility lines
- n. Show scale

10. Any two of the following:
    - a. Plotting the boundary from the legal description
    - b. Plotting by coordinates
    - c. Plotting by latitudes and departures

11.-15. Evaluated to the satisfaction of the instructor

TOPOGRAPHIC MAPPING
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to interpolate contours from a grid survey, prepare profiles from the contour map, and calculate grades in percent. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to topographic maps with the correct definitions.
2. List uses of topographic maps.
3. Match types of surveys used in topographic mapping with the size of area to be mapped.
4. Select from a list the field methods for obtaining topography.
5. List factors affecting the selection of the field method to be used for a topographic survey.
6. Distinguish between horizontal and vertical controls for topographic surveys.
7. Arrange in order the steps in laying out a topographic survey.
8. Match the methods used to establish contours with the correct descriptions.
9. Complete statements concerning national standards for horizontal and vertical accuracy on topographic maps.
10. Complete a chart of scale ratios used in the USGS topographic series.

OBJECTIVE SHEET

11. Select true statements concerning the selection of contour intervals.
12. Complete statements concerning characteristics of contour lines.
13. Match contour line features with their correct configurations.
14. Select true statements concerning the common methods used to calculate area from a topographic map.
15. Arrange in order the steps in calculating cut and fill using the contour area method.
16. Complete statements concerning the steps in developing and plotting a profile from profile leveling notes.
17. Arrange in order the steps used to develop a profile from a contour map.
18. List three methods for plotting contours lines.
19. Select true statements concerning fixing a grade line.
20. Complete statements concerning aerial photogrammetry.
21. Distinguish between advantages and disadvantages of using aerial photography for mapping work.
22. Complete statements concerning applications of aerial photogrammetry.
23. Select true statements concerning aerial photo control.
24. Arrange in order the steps for using a stereoscope.
25. Interpolate contours from a grid survey and prepare profiles from the contour map. (Assignment Sheet #1)
26. Set up contours in isometric. (Assignment Sheet #2)
27. Calculate grades in percents. (Assignment Sheet #3)

TOPOGRAPHIC MAPPING
UNIT VIII

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Obtain aerial photos for the U.S.G.S. quad map of your local area.
2. Call or write to the NCIC Headquarters/U.S.G.S. for information on how to order topographic maps for your area.

   NCIC Headquarters
   National Cartographic Information Center
   U.S. Geological Survey
   507 National Center
   Reston, VA 22092
   703/860-6045

3. Take a field trip and identify contour configurations on the ground.
4. Choose an area around the school and prepare an isometric sketch of the terrain.
5. Show examples of aerial photographs, orthophotographs, and stereo models.
6. Demonstrate the use of a stereoscope, and have students practice viewing aerial photos.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

  1. TM 1 — Random Shot Method for Establishing Contours
  2. TM 2 — Grid Method for Establishing Contours
  3. TM 3 — Cross Profile Method for Establishing Contours
  4. TM 4 — Leveling Procedure
  5. TM 5 — Example of a Grading Plan

D. Assignment sheets

  1. Assignment Sheet #1 — Interpolate Contours from a Grid Survey and Prepare Profiles from the Contour Map
  2. Assignment Sheet #2 — Set Up Contours in Isometric
  3. Assignment Sheet #3 — Calculate Grades in Percents

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Glossaries of BLM Surveying and Mapping Terms*, 2nd ed. Bureau of Land Management/U.S. Department of the Interior, 1980.

B. *Definitions of Surveying and Associated Terms*. American Congress on Surveying and Mapping and the American Society of Civil Engineers, 1978.

C. Nelson, John A. *Drafting for Trades and Industry: Civil*. Albany, NY: Delmar Publishers, 1979.

D. Bies, John and Robert Long. *Mapping and Topographic Drafting*. Cincinnati, OH: South-Western Publishing Co., 1983.

E. Steele, Robert. *Modern Topographic Drawing*. Houston, TX: Gulf Publishing Co., 1980.

F. *Map Drafting and Related Computations for Plane Surveying: Field Book*. Natchitoches, LA: Vocational Curriculum Development and Research Center, 1965.

G. *Mapping*. ICS, Staff & Clifton O. Carey. Scranton, PA: International Textbook Co., 1937.

H. Lynch, Kevin. *Site Planning*. Cambridge, MA: MIT Press, Massachusetts Institute of Technology, 1962.

REFERENCES USED IN DEVELOPING THIS UNIT

I. *Map Reading*, FM 21-26. Department of Defense/Department of the Army Field Manual. Washington, DC: Government Printing Office.

J. Hoelscher, Randolph, Clifford Springer, and Jerry Dobrovolny. *Graphics for Engineers*. New York: John Wiley and Sons, Inc., 1968.

TOPOGRAPHIC MAPPING
UNIT VIII

INFORMATION SHEET

I. **Terms and definitions**

A. Aerial photograph — A photograph taken from an airborne vehicle

B. Backsight — A survey reading taken on a point of known elevation for the purpose of obtaining the height of the instrument; also called a plus(+) sight

C. Contour interpolation — Determination of an intermediate value between field values from some known or assumed rate; estimating of contours

D. Contour interval — The vertical distance between the planes of consecutive contour lines, such as 5, 10, 20, 100, or 200

E. Contour line — An imaginary line on the ground connecting all points that are the same elevation above or below sea level

F. Cut and fill — A road construction term that describes the quantities of earth removed from hillsides and filled into low spots

G. Datum — Any numerical or geometrical quantity or set of such quantities that serves as a reference or base for other quantities

Example: Mean sea level serves as a datum for elevation

H. Depression contour lines — Indicate an elevation that represents a low place on the ground that has no surface drainage

I. Foresight — A survey reading taken on a new point to determine its elevation; also called a minus (–) sight

J. Grade — An established elevation of the ground or a road surface; the amount of incline or slope from the horizontal expressed usually in percentages

K. Gradient — The rate of grade

L. Grading plan — A plan containing original ground contours over which contours of the highway, subdivision, or other embankment or excavation to be completed are superimposed on and connected with the original ground contours at the edge of construction limits

M. Index contour line — Every 5th contour line, which is numbered

N. Intermediate contour lines — Contour lines that are between index contours

O. Isometric map — A map that shows relief by conventions such as contours, hachures, shading, and tinting

INFORMATION SHEET

P. Photogrammetric surveying — The science of obtaining measurements by means of photographs, usually aerial photographs

Q. Sea level — Topographic datum line which is the level between high and low tide

R. Spot elevation — A point on a map or chart whose height above a specified reference datum is noted, usually by a dot or small "x" and elevation value

S. Stadia — Refers to distance and elevation measurements that have been obtained by surveying methods

T. Stereoplotter — A piece of equipment that allows the operator to view the stereo model in 3-dimension; from this model topographic and planimetric information can be traced out for future development of a map

Examples: Kelsh, Kern, Ball Plex plotters

U. Stereoscope — A pocket size stereoviewer consisting of two magnifying lenses in a metal frame that allows ease in viewing aerial photographs without having to use a stereoplotter

V. Stereoscopic model — The area covered by two overlapping or stereo pair of photos

W. Stereovision — The ability to see three-dimensionally (length, width, and depth at the same time) using two views of a single object from two slightly different positions

X. Supplemental contour lines — Represent half intervals between contour lines

Y. Topographic map (as defined by U.S. Geological Survey) — A line and symbol representation of natural and selected man-made features of a part of the earth's surface plotted to a definite scale; distinguishing characteristic is the portrayal of the shape and elevation of the terrain by contour lines

II. **Uses of topographic maps**

A. As bases for other maps

Examples: County planning maps, drainage basin maps, geologic maps, land ownership maps, shaded relief maps

B. Planning highways

C. Selecting airport sites

D. Selecting industrial sites

INFORMATION SHEET

E. Routing pipelines and power lines

F. Locating boundary lines for cadastral surveys

G. Planning communication facilities

H. Aiding in agricultural research

I. Planning recreation areas

J. Assessing and managing natural resources

III. Types of surveys used in topographic mapping

A. Aerial (photogrammetric) — Used for mapping projects covering large areas more than 40 acres

B. Ground (field) survey — Used for large scale maps of small areas less than 5 acres

(NOTE: Often both methods are used in combination. When photogrammetry is used, ground control and field checks are done by a ground survey.)

IV. Field methods for obtaining topography

A. Radial method

B. Stadia method

C. Planetable method

D. Coordinate squares method

E. Offsets from the center line

F. Contours by hand level

V. Factors affecting the selection of the field method to be used for a topographic survey

A. Purpose of survey

B. Map use (accuracy required)

C. Map scale

D. Contour interval

E. Size and type of area involved

INFORMATION SHEET

F. Cost

G. Equipment and time available

H. Experience of survey personnel

VI. Controls for topographic surveys

A. Horizontal control

1. Provided by two or more points on the ground, precisely fixed in position by distance and direction

2. Control established by:

   a. Traversing — Small land areas

   b. Triangulation] Large land areas

   c. Trilateration] Large land areas

   d. Inertial and satellite methods — Technical advances for establishing control for large land masses

B. Vertical control

1. A vertical control net is established by lines of levels starting from and closing on bench marks.

2. Elevations are established for all traverse hubs.

3. Topographic details are usually built upon a framework of traverse hubs whose positions and elevations have been established.

VII. Steps in laying out a topographic survey

A. Run an accurate closed traverse within the area to be mapped.

(NOTE: Even when an open traverse is run, a closure check is done by connecting the two end stations.)

B. Calculate latitudes and departures, adjust traverse, and calculate coordinates.

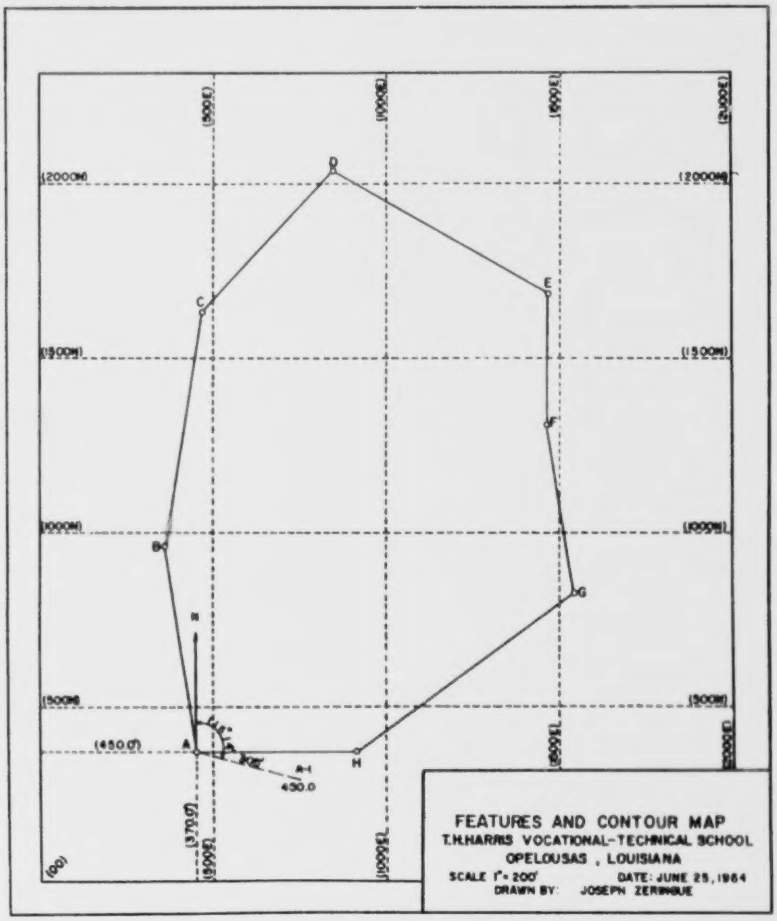
INFORMATION SHEET

C. Using the coordinates, plot the traverse.

(NOTE: This establishes horizontal control.)

Example:

FIGURE 1


(500E)
(1000E)
(1500E)
(2000E)
(2000N)
(2000N)
D
E
C
(1500N)
(1500N)
F
(1000N)
(1000N)
B
G
N
(500N)
(500N)
(450.0')
A
A-1
430.0
H
(370.0')
(500E)
(1000E)
(1500E)
(2000E)
(0,0)
FEATURES AND CONTOUR MAP
T.H.HARRIS VOCATIONAL-TECHNICAL SCHOOL
OPELOUSAS , LOUISIANA
SCALE 1"=200'
DATE: JUNE 25, 1964
DRAWN BY: JOSEPH ZERINGUE

Reprinted with permission of the Vocational Curriculum Development and Research Center, Natchitoches, LA.

D. From the points located by the horizontal control traverse, make a survey (usually stadia) locating all the details of features to be shown.

E. Establish contours from vertical control.

INFORMATION SHEET

VIII. Methods used to establish contours

A. Random shot method (Transparency 1)

1. Establishes horizontal and vertical control.
2. Locates details by direction and distance from a control point.
3. Usually uses theodolite (transit) — stadia method or EDM.
4. Stadia distance is recorded and vertical angle is read for each point; then horizontal distance and elevation are calculated.
5. Contours can be drawn by interpolation or estimation connecting all points of equal elevation.

B. Trace contour method — The points on the ground are the elevation of the desired contour established by random shot method. Lines on the map are drawn connecting points of the same elevation.

C. Grid method (Transparency 2) — The map is divided into a system of squares or rectangles. The elevations at the corners and critical points on the lines are located. The grid and elevations are plotted and the contours are then drawn by interpolation.

D. Cross profile method (Transparency 3) — Lines are run out at right angles to the traverse line. Contour points or elevations at changes in slope are established on these lines with their distances out from the traverse. Points are then plotted and points of equal elevation are joined by contour lines. This method is used for development of cross sections for transportation plans.

IX. National standards for accuracy on topographic maps

A. Horizontal accuracy — Requires no more than 10 percent of well-defined map points tested to be more than 1/50 inch (0.5mm) out of correct position at publication scales of 1:20,000 or smaller.

B. Vertical accuracy — Requires that no more than 10 percent of the elevations of test points interpolated from contours be in error more than half the contour interval.

INFORMATION SHEET

X. Scales for topographic map series — U.S.G.S.

Series	Scale	One Inch Represents	Standard Quadrangle Size (latitude & longitude)	Quadrangle Area (square miles)
7.5-minute	1:24,000[1]	2,000 feet	7.5 × 7.5 min.	49 to 71
15-minute	1:62,500[2]	about 1 mile	15 × 15 min.	197 to 282
Intermediate-scale quadrangle	1:100,000	over 1.5 miles	30 min. × 1°	1,145 to 2,167
U.S. 1:250,000[3]	1:250,000	about 4 miles	1° × 2°	4,580 to 8,669
International Map of the World	1:1,000,000	about 16 miles	4° × 6°	73,734 to 102,759

[1] For Alaska, the scale is 1:25,000 and for Puerto Rico, 1:20,000.

[2] For Alaska, the scale is 1:63,360 (1 inch represents 1 mile) and the quadrangle size is 15 × 20 to 36 minutes.

[3] Maps of Alaska and Hawaii vary from these standards.

XI. Selection of contour intervals

A. Standard of accuracy required affects the selection of a contour interval.

Example: National standards can interpolate a map within 1/2 contour interval. If accuracy required is 1 foot, then a 2 foot maximum interval is necessary.

B. Terrain type regulates the contour interval.

1. Rugged terrain requires a larger contour interval.
2. Flat ground uses a small contour interval to show the surface adequately.

C. If map scale is reduced, the contour interval is increased.

D. 5, 10, 20, 100, and 200 feet are the intervals most commonly used.

E. U.S.G.S. commonly uses 40 foot contour intervals.

F. Defense Mapping Service (DMS) commonly uses 50 foot contour intervals.

G. Contour interval should not vary on any one map.

(NOTE: Some maps that represent very flat terrain may employ 1/2 contours. These are usually shown as dashed.)

H. Common rule on contour intervals is not to show more than 10 contours per linear inch.

INFORMATION SHEET

XII. Characteristics of contour lines

A. A contour is a line, all points of which lie at equal elevations.

B. Every contour closes upon itself either within or without the limits of the map; in the latter case it is drawn to the edge of the map.

C. A contour line closing within the limits of the map either indicates a summit or a depression. If the depression does not enclose a body of water, it should be numbered or hachured to indicate its elevation.

D. Contours never cross each other, except in the case of an overhanging cliff or a cave, and then they must cross twice. Such cases seldom occur, but if they do, the lower contour should be dotted.

E. On uniform slopes, contours are evenly spaced.

F. On a plane surface, contours are straight lines, parallel to each other.

G. The distance between contours varies inversely as the slope.

H. The sharpest bends in contours occur at their intersection with ridge and valley lines, which they cross at right angles.

I. A single contour cannot intervene between two other contours having the same elevation either on a summit or in a valley.

Example: The maximum ridge and minimum valley contours must occur in pairs if they do not close within the limits of the map.

J. One contour cannot be superimposed upon another except where they indicate a vertical cliff.

K. Contours bend toward the upgrade when crossing a valley or depression, and toward the down grade when crossing a ridge line.

L. Contours crossing a railroad laid to an even grade will be spaced at equal intervals.

M. Contour lines crossing a stream point upstream and form V's; they point down the ridge and form U's when crossing a ridge crest.

N. Contour lines cannot run into the shore of a lake or other still body of water since the water surface is at the same level at all points.

O. It is customary to make every fifth contour line (index contour) heavier than the rest. The line is broken at some convenient place and the number representing the elevation is inserted. When contour lines are far apart, each one may be numbered.

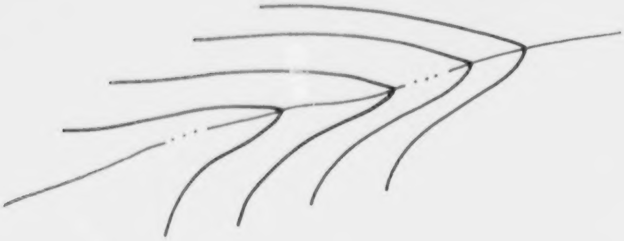
P. On a summit or low point the last contour line is labeled and the elevation within the contour is given.

INFORMATION SHEET

XIII. **Typical contour line configurations**

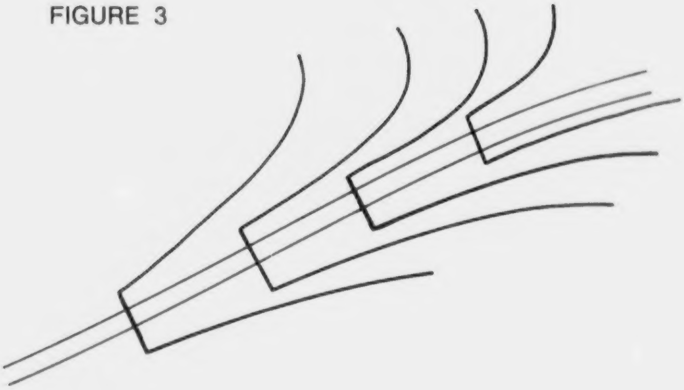
A. Stream

FIGURE 2



B. Embankment

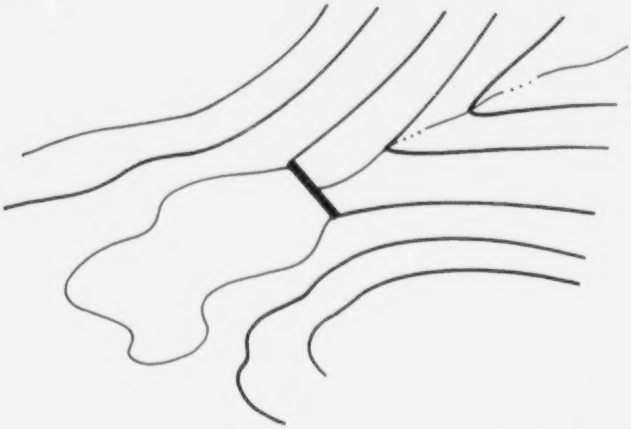
FIGURE 3



INFORMATION SHEET

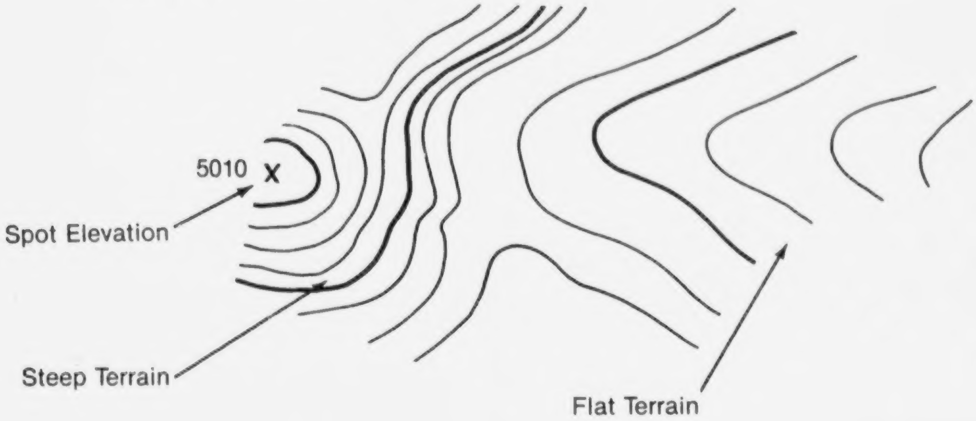
C. Dam

FIGURE 4



D. Steep and flat terrain

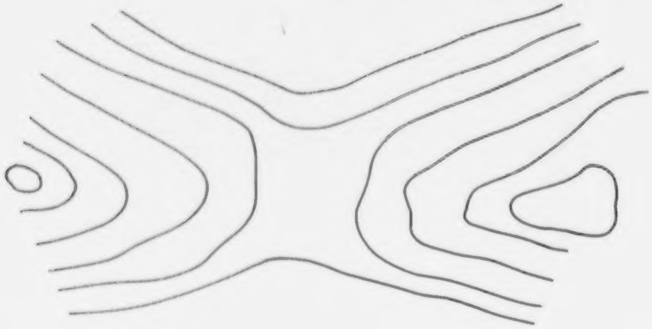
FIGURE 5


5010 X
Spot Elevation
Steep Terrain
Flat Terrain

INFORMATION SHEET

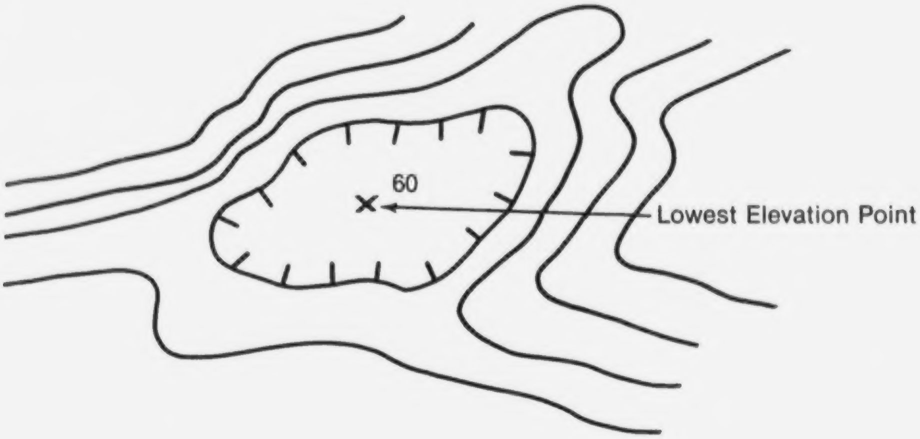
E. Saddle

FIGURE 6



F. Depression contour

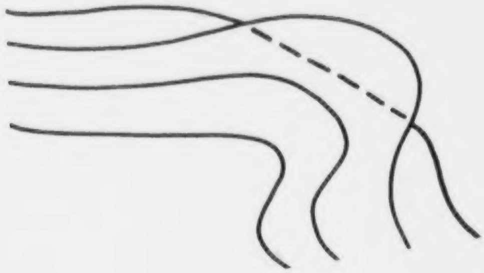
FIGURE 7


60
Lowest Elevation Point

INFORMATION SHEET

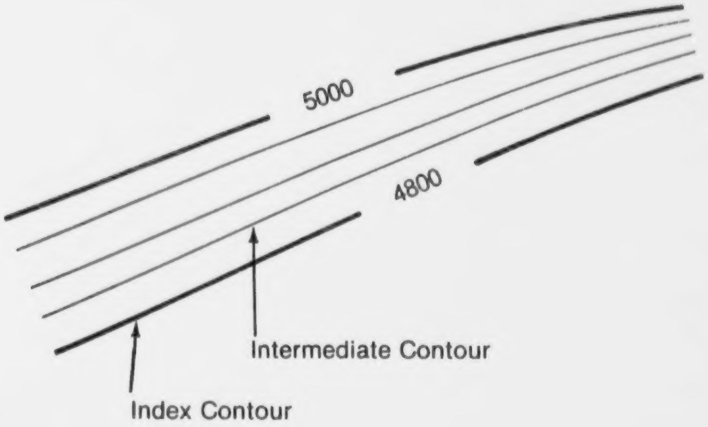
G. Overhang or cliff

FIGURE 8



H. Index and intermediate contours

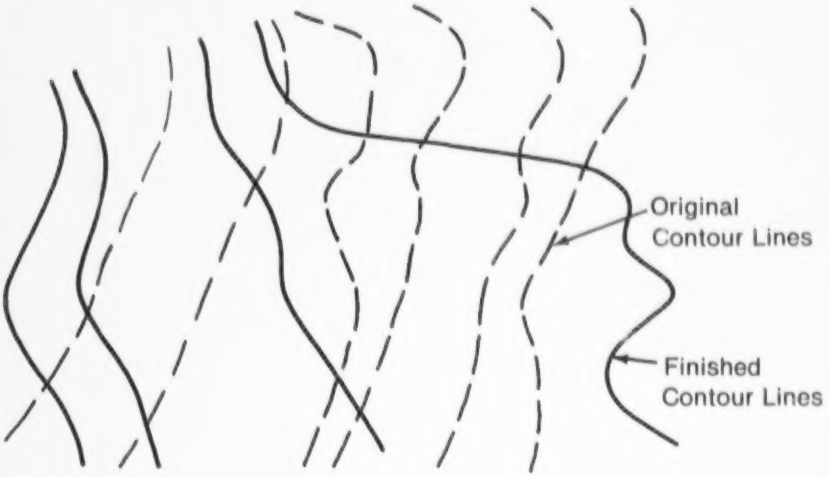
FIGURE 9


5000
4800
Intermediate Contour
Index Contour

INFORMATION SHEET

I. Original and finished contours

FIGURE 10



XIV. Methods used to calculate area from a topographic map

A. Planimeter method

1. Standardization — Standardize the planimeter for a known area on the *same paper medium* as the map. With the planimeter tracing point, FREEHAND the boundary of the known area in a CLOCKWISE direction.

2. Calculations — Divide the known area by the average reading. Each value of the planimeter counter is now equal to a known area.

3. Unknown area — Trace the unknown area in a *clockwise* direction. Repeat at least 2 times and average by the area value for the total area.

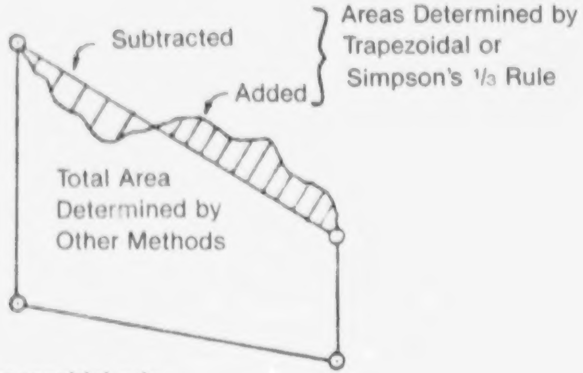
   (NOTE: This procedure is covered in more detail in Unit VI, Job Sheet #2.)

INFORMATION SHEET

B. Irregular boundaries methods

(NOTE: The area of a parcel of land bound by an irregular boundary, such as a shore or a river, cannot be determined uniquely like the area of a rectangle, trapezoid, etc. Several *approximate methods* are possible (trapezoidal, Durand's, Simpson's rule, etc.) and all are based on the concept of subdividing the total area into n-strips. The boundary then approximates a straight line (trapezoidal rule) or a known curve (parabola = Simpson's rule), and the total area then becomes the sum of the individual, calculatable areas. The greater the number of strips used, the more accurate the area and the easier it will be to draw the boundary on the plat.)

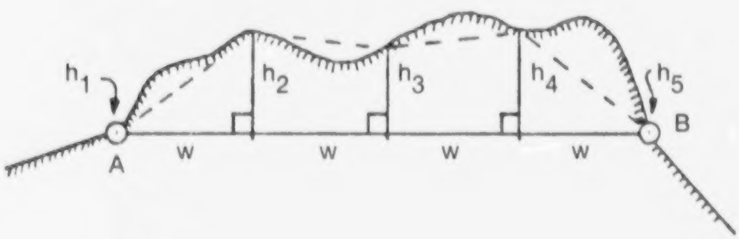
FIGURE 11


Subtracted
Added
Areas Determined by Trapezoidal or Simpson's 1/3 Rule
Total Area Determined by Other Methods

1. Trapezoidal rule

   a. Given an irregular boundary, divide the baseline (AB) into any desired, but *regular* intervals (w). From the baseline establish *perpendicular* offsets (h_1, h_2, etc.) to the boundary. See Figure 12.

FIGURE 12


h_1
h_2
h_3
h_4
h_5
A
B
w
w
w
w

INFORMATION SHEET

b. The area of a trapezoid is:

$$A = w\left(\frac{h_a + h_b}{2}\right)$$

c. The total area of several adjacent trapezoids is: (See Figure 12)

$$A_T = w\left(\frac{h_1 + h_2}{2}\right) + w\left(\frac{h_2 + h_3}{2}\right) + w\left(\frac{h_3 + h_4}{2}\right) + \ldots + w\left(\frac{h_n - 1 + h_n}{2}\right)$$

d. Combining the above mathematically gives the equation for the trapezoidal rule.

$$A_T = w\left(\frac{h_1 + h_n}{2} + h_2 + h_3 + \ldots + h_{n-1}\right)$$

WHERE:
A_T = total area
w = interval spacing (constant)
h = perpendicular offset distances
Note: Some offsets *may be* zero (0).

Example: Given:
w = 20.00ft
h_1 = 0.00ft
h_2 = 16.08ft
h_3 = 14.73ft
h_4 = 15.91ft
h_5 = 0.00ft

$$A_T = 20.00\text{ft}\left(\frac{0.00\text{ft} + 0.00\text{ft}}{2} + 16.08\text{ft} + 14.73\text{ft} + 15.91\text{ft}\right)$$

$= 934.4\text{ft}^2$ = Answer

INFORMATION SHEET

2. Simpson's rule (or Simpson's 1/3 rule)

(NOTE: Simpson's rule is similar to the trapezoidal rule, but it assumes that the curve through each successive 3 points is a portion of a parabola. It normally gives a better fit (area) than the trapezoidal rule.)

a. Given an irregular boundary, divide the baseline (AB) into an *even number* and *regular* intervals (w). From the baseline establish *perpendicular* offsets (h_1, h_2, etc.) to the boundary.

b. Label *all* offsets, by starting with h_1 at the beginning of the baseline.

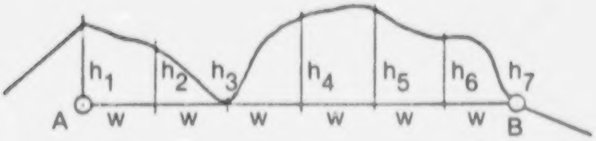
c. *Equation:* Simpson's rule

$$A_T = \frac{w}{3}\left[(h_1 + h_n) + 4\,\Sigma h_{even} + 2\,\Sigma h_{odd}\right]$$

WHERE: A_T = Total area
w = Interval spacing (constant)
h = Perpendicular offset distance
Note: Some offsets may be zero (0).

Example:

FIGURE 13



Given: w = 11.59 ft
h_1 = 10.52 ft (FIRST)
h_2 = 9.03 ft
h_3 = 0.00 ft
h_4 = 13.74 ft
h_5 = 13.86 ft
h_6 = 7.52 ft
h_7 = 0.00 ft (LAST)

Solution:

$$A_T = \frac{w}{3}\left[(h_1 + h_n) + 4\,\Sigma h_{even} + 2\,\Sigma h_{odd}\right]$$

$$A_T = \frac{11.59\text{ft}}{3}\ (10.52\text{ft} + 0.00\text{ft}) +$$

$$4\,(9.03\text{ft} + 13.74\text{ft} + 7.52\text{ft}) + 2\,(0.00\text{ft} + 13.86\text{ft})$$

$= 615.82\ \text{ft}^2 = 616\ \text{ft}^2$ (to 3 sig. fig.) = **Answer**

INFORMATION SHEET

XV. **Steps in calculating cut and fill using the contour area method**

(NOTE: Grading plan must be in place. This method is adequate for general quantity estimates.)

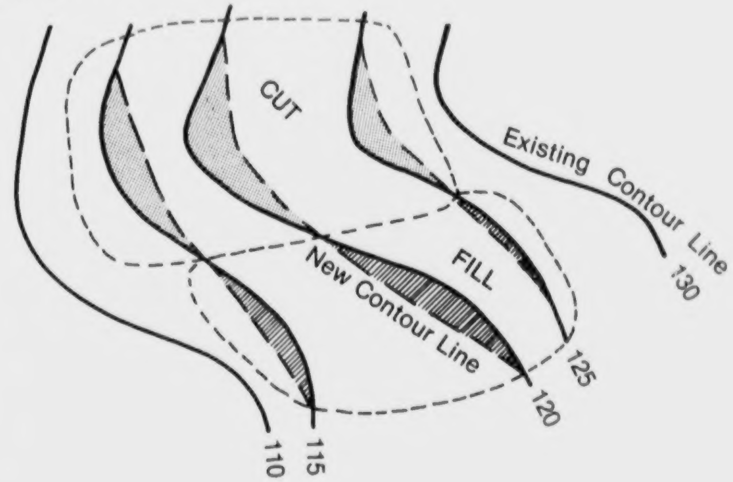
A. Make an earthwork diagram on the grading plan.

B. Draw boundary lines of no-cut, no fill.

C. Bring out new contours where they differ from the old by interconnecting the points where the new contours rejoin the old ones.

D. Shade the areas between old and new contours at each level, using one color for cut and another for fill.

FIGURE 14



E. Measure the shaded areas with a planimeter.

F. Approximate the volume of the cut and fill by multiplying the contour interval by the sum of shaded areas.

Example: In Figure 15 the contour interval is 5 feet.
Total volume (V) in cubic feet is:
$V = 5(A_1 + A_2 + A_3)$

XVI. **Steps in developing and plotting a profile from profile leveling notes** (Transparency 4)

A. Stakes are set up at regular intervals (range from every 25, 50, 100 feet, depending on regularity of the ground).

INFORMATION SHEET

B. Station 0+00 is the beginning point. It is always positive relative to a known bench mark (BM).

(NOTE: A known bench mark gives the survey team an exact location and elevation to work from, and allows for mathematic checks for elevation readings.)

C. Obtain the elevation at station 0+00.

1. Level is set near station 0+00 and a plus reading (backsight) is taken from the BM.
2. The plus reading is added to the elevation of the BM to give the HI (height of instrument).
3. Foresights are then read on as many full station points as can be taken conveniently from the positions of the instrument.
4. The foresight readings are subtracted from the HI to obtain the elevations.

D. When necessary to take readings on stations ahead, the level is moved forward to a TP (turning point) or next station and a reading is taken. The reading is subtracted from the HI which gives the elevation of the TP or that station.

1. A TP is established when a rod reading exceeds 150 feet or is obstructed from observation dependent on terrain and temperature.
2. The first turning point would be labeled TP1.
3. A reading is taken on each TP and subtracted from the HI to give the elevation at that point.

E. Profile leveling should be terminated at another bench mark. Usually the survey returns to the starting point for a check on the error of closure on that survey.

INFORMATION SHEET

F. Check calculations — Add the initial elevation and the total (Σ) of backsights, then subtract the total (Σ) foresights, and this should equal the final elevation.

FIGURE 15

STA	+	HI	−	ROD	ELEV
BM#5	5.02	62.27			57.25
TP#1	0.27	55.28	7.26		55.01
0+0				3.34	51.94
1+0				4.42	50.86
TP#2	2.66	48.52	9.42		45.86
2+0				9.75	38.77
BM#6			7.17		41.35
Σ	7.95		23.85		
Check:			57.25		
			+ 7.95		
			65.20		
			− 23.85		
			41.35	Check OK	

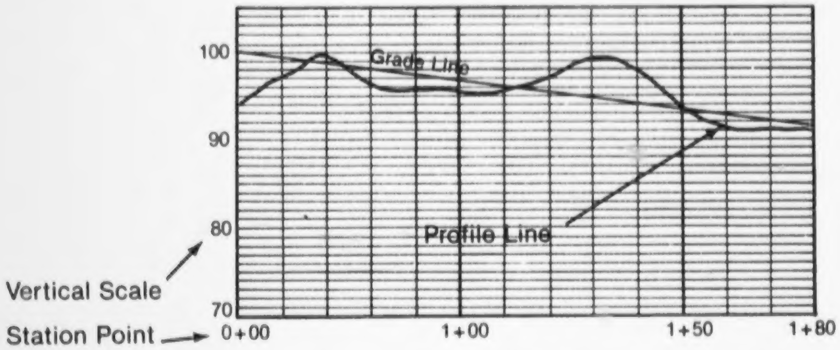
G. Plot the profile from the field notes.

1. Use profile paper for layout.
2. Establish appropriate horizontal and vertical scales.

INFORMATION SHEET

3. Using the information given in the level notes for the elevation for each station (point), begin to plot elevation points starting at station 0+00.

FIGURE 16



4. Once all elevations are plotted, the points should be connected with a smooth line.

XVII. Developing a profile from a contour map

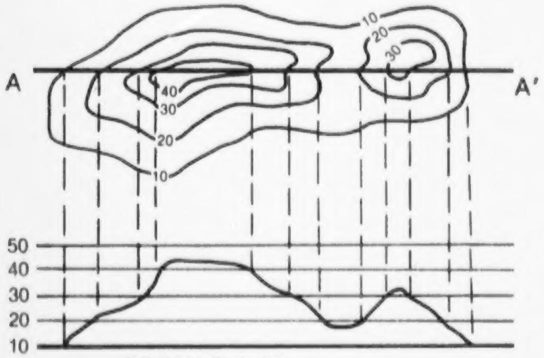
(NOTE: This is the least common method of plotting profile. The preferred method is from profile field notes.)

A. Contour map is placed above the profile grid and is then considered the plan view.

B. The location of the cross section cutting plane line is marked on the contour drawing.

C. The extremes of elevations are determined from the cutting plane line on the contour map.

FIGURE 17



PROFILE A-A'

INFORMATION SHEET

D. Appropriate vertical scale is selected and is labeled on the profile paper with the elevation required.

(NOTE: It is customary in civil engineering to draw the profile to an exaggerated vertical scale. Horizontal scale is already determined by the contour drawing.)

E. The point of intersection of the cutting plane line and the contour line is projected to the profile.

(NOTE: The elevation of the intersecting contour should correspond to the same profile elevation.)

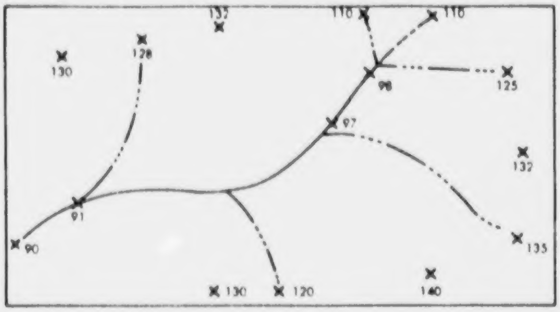
F. The projected points are connected with a smooth continuous line and any elevations or features are labeled.

XVIII. Methods for plotting contour lines

A. Random pattern plotting from stadia notes

1. Given: A series of random points (elevations) located in critical points such as ridges, summits, stream junctions, gullies, etc. This theory of contouring works on the assumption that the slope between two points is constant.

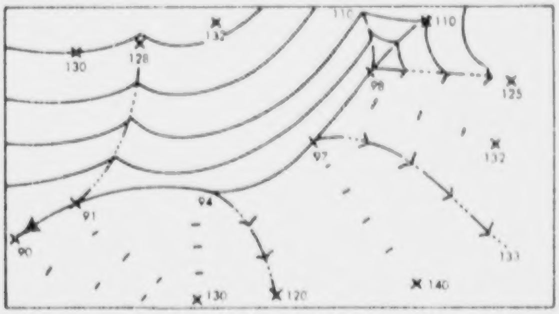
FIGURE 18



INFORMATION SHEET

2. Along the main stream line, interpolate the elevations of all stream junctions not given.

FIGURE 19

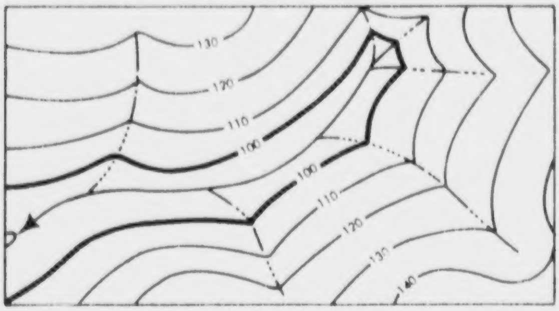

110
110
132
130
128
98
125
132
97
94
91
90
133
140
130
120

3. Using these tick marks along the streams, it is possible to interpolate the contour intervals. The contours crossing at the stream "V" with the "V" pointing upstream.

4. Next interpolate the contour intervals on the hills between the stream beds using the placement of contour intervals on the streams as a guide.

5. Finalize the contours, completing one contour at a time. Make sure the subsequent contour conforms to the previous contour.

FIGURE 20

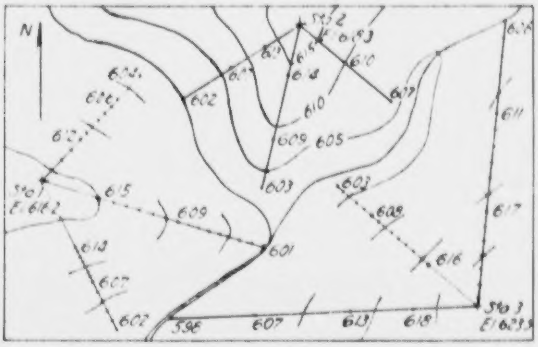

130
120
110
100
100
110
120
130
140

INFORMATION SHEET

B. Radial pattern contouring

1. Given from field notes a radial pattern of elevation points from a traverse point.

FIGURE 21


N
Sta 2
E 615.3
615
618
610
602
610
609
605
603
Sta 1
E 616.2
615
609
601
603
608
616
611
617
613
607
602
598
607
613
618
Sta 3

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2. Assuming the slope between elevation points is even, the distance between points can be divided into a number of spaces equal to the difference in elevation between points.

3. Then the tick marks which fit the contour interval are connected with a smooth conforming line.

   (NOTE: It is here where contour interpolation takes on artistic form. When in doubt, always make contour lines parallel to each other and evenly spaced between control points.)

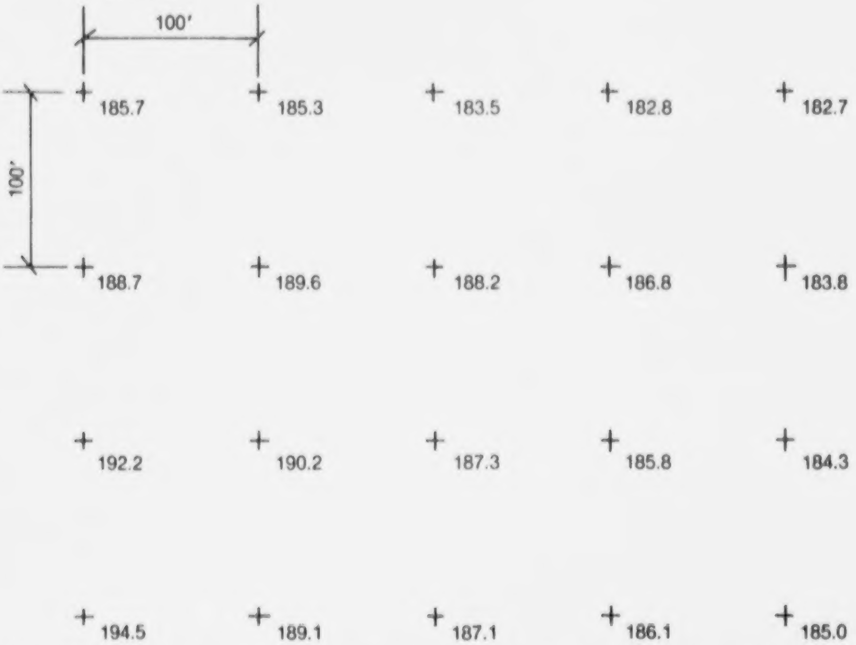
C. Contouring from a grid pattern

1. Given from field notes a series of elevations that lay out in a grid pattern.

INFORMATION SHEET

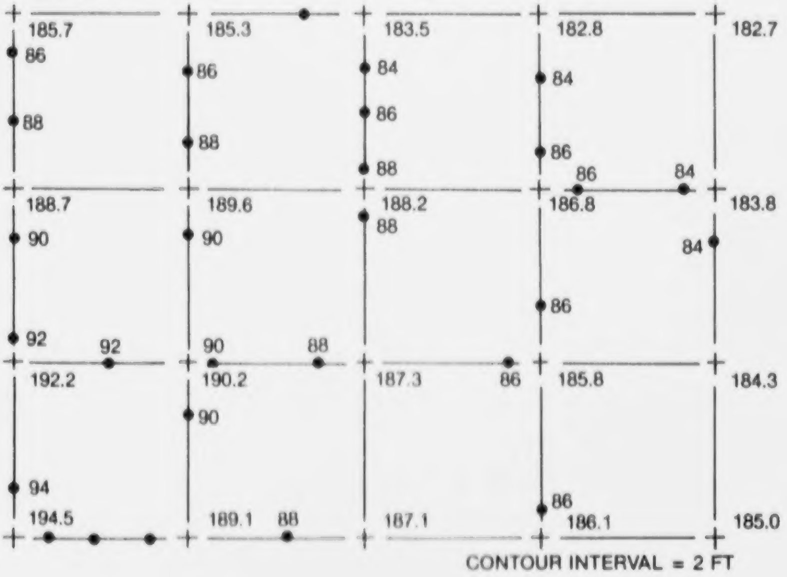
2. Establish the grid points with the appropriate scale. Label each grid point with its assigned elevation.

FIGURE 22


100'
100'
185.7
185.3
183.5
182.8
182.7
188.7
189.6
188.2
186.8
183.8
192.2
190.2
187.3
185.8
184.3
194.5
189.1
187.1
186.1
185.0

3. Determine how many contour intervals fall between each grid point. Use a scale or dividers to locate each point of interval between grid points.

FIGURE 23

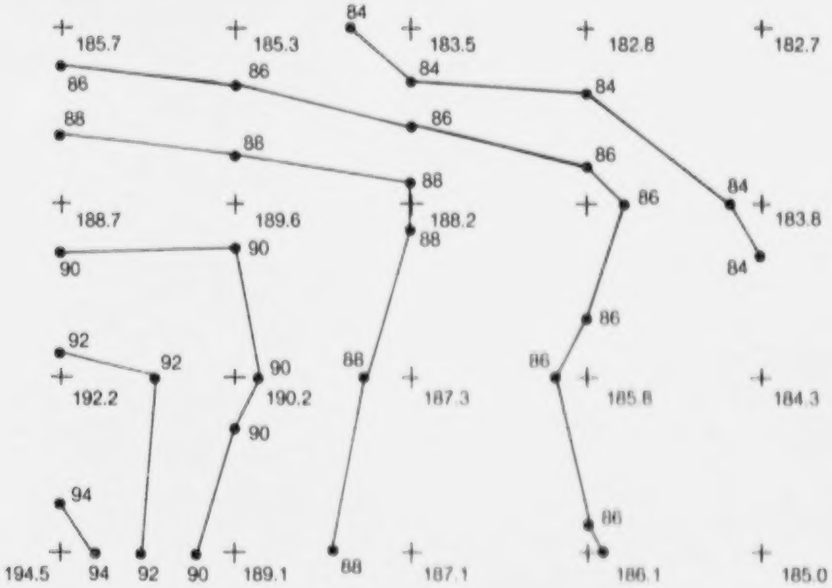

185.7
185.3
183.5
182.8
182.7
86
86
84
84
88
86
88
88
86
86
86
84
188.7
189.6
188.2
186.8
183.8
88
90
90
84
86
92
92
90
88
192.2
190.2
187.3
86
185.8
184.3
90
94
86
194.5
189.1
88
187.1
186.1
185.0
CONTOUR INTERVAL = 2 FT

INFORMATION SHEET

4. Carefully connect lines of the same elevation.

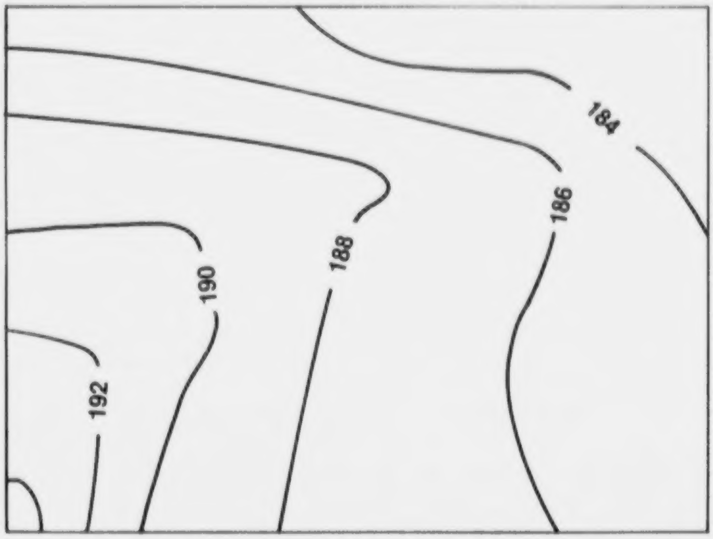
   (NOTE: Lines should not cross and if a question occurs, a site visit may be necessary to clarify the lay of the land.)

   FIGURE 24


84
185.7
185.3
183.5
182.8
182.7
86
86
84
84
88
86
88
86
88
84
188.7
189.6
188.2
86
183.8
90
90
88
84
86
92
92
90
88
86
192.2
190.2
187.3
185.8
184.3
90
94
86
194.5
94
92
90
189.1
88
187.1
186.1
185.0

5. Smooth out contour lines to follow evenly with each other. Assign labeling to index contours.

   FIGURE 25


184
186
188
190
192

INFORMATION SHEET

XIX. **Fixing grade line** (Transparency 5)

A. Ground profile is used as the basis of study to fix the grade location.

B. Factors that control grade:

1. Location of stream crossings
2. Beginning and ending points
3. Routes through towns and villages
4. Maximum rates of grade for the type of traffic using the highway or railway

C. Grade is selected and fitted to the ground so as to eliminate excessive cut and fill.

D. The amount of dirt removed from the cuts should closely equal the amount required to fill the low areas to avoid expensive hauling of fill dirt.

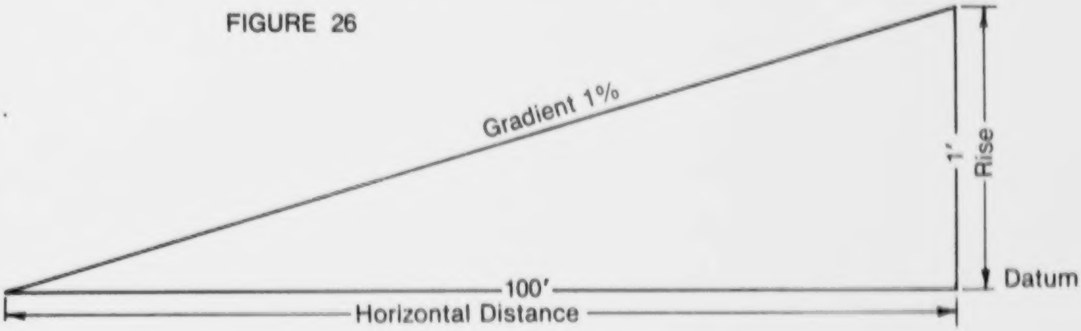
E. The gradient is found by dividing the amount of rise by the horizontal distance.

F. The percent of grade is found by multiplying the gradient by 100.

Example: If a road uses one foot vertically in a horizontal distance of 100 feet, it has a 1% grade.

G. Example of mathematical relationships

FIGURE 26



$$\text{Percent of grade} = \frac{\text{Rise}}{\text{Distance}} \times 100$$

H. Depending on the type of project, the grade line will pertain to different slopes.

1. Highways, roads, and bridges — Grade is the finished vertical cross section at center line.
2. Other structures — Grade line represents subgrade.
3. Railroads — Grade line represents the location of the base rail.

INFORMATION SHEET

I. Grade when calculating cut and fill

1. Grade higher than elevation in the profile; a notation to fill is shown

   Example: F 5.67′

2. Grade below the profile elevation, a cut notation is used.

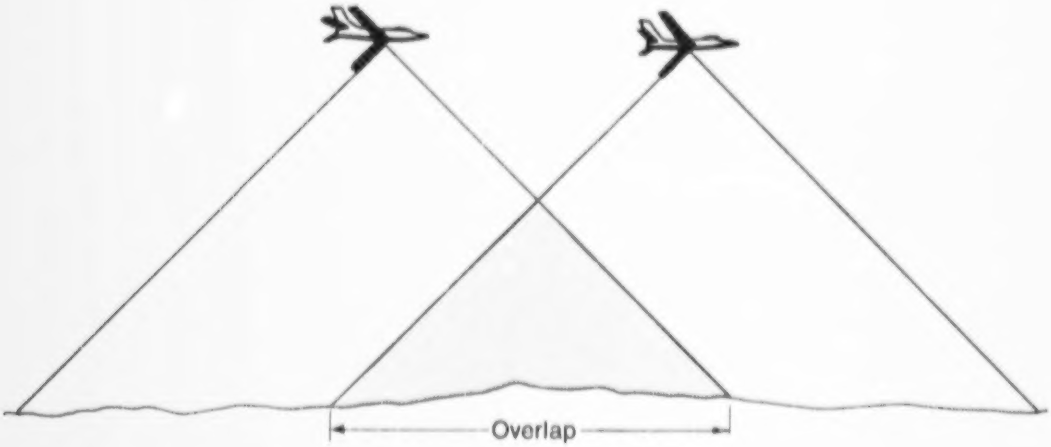
   Example: C 2.87′

XX. General facts about aerial photogrammetry

A. Aerial photos of most of the United States are available for a fee through federal, state, and local government agencies.

B. Photographs may be taken from airplanes, satellites, or ground stations.

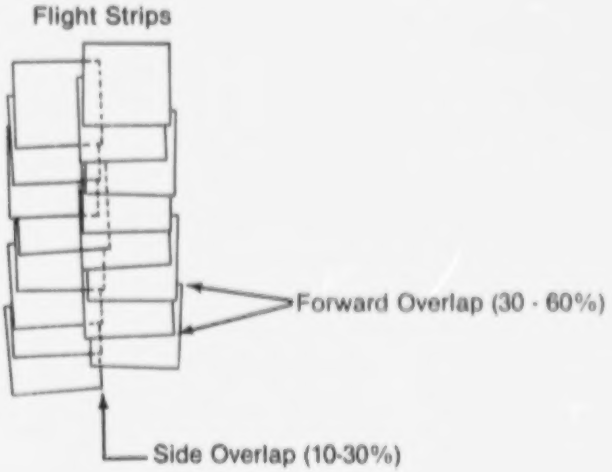
FIGURE 27



INFORMATION SHEET

C. Aerial photographs are taken in sequential order, usually with 30-60 percent forward overlap and 10-30 percent side overlap.

FIGURE 28



D. The minimum contour interval accurately obtainable from aerial photos depends on the height of the flight above the ground.

E. The scale of the aerial photo is the ratio of the camera focal length to the height of the flight above ground.

$$\text{Scale (RF)}\ \frac{\text{Photo Distance}}{\text{Ground Distance}}$$

XXI. **Advantages and disadvantages of using aerial photography for mapping work**

A. Advantages

1. Speed at which work is accomplished
2. Wealth of detail secured
3. Access to areas difficult to reach by ground

B. Disadvantages

1. Cost of flying a project
2. Availability of aerial photos for all areas
3. Distortion around edges of aerial photos due to curvature of the earth

INFORMATION SHEET

XXII. **Applications of aerial photogrammetry**

A. Stereo compilation and photo interpretation

Examples: Topographic maps, route survey

B. Photo mosaic — A composite of several aerial photos tied together to represent a large area

C. Photo map — Map size reproduction of a mosaic map with added information drafted over the photo

D. Orthophoto — Orthographic photograph that results from processing aerial photographs to remove distortions and displacements due to relief and tilt

E. Analytical aerotriangulation — Producing coordinates of photo control points by mathematical procedures using computers

XXIII. **Aerial photo control**

A. Control points for the survey are located in the field, identified and marked on the photo, and used to set up a stereo model.

B. Horizontal control for a stereo model

1. A baseline measurement of two clearly identifiable points from the ground within the model area is required.
2. This baseline should be long enough to measure 3 or more inches on the photo.
3. Baseline measurement should be provided every third or fourth model.

C. Vertical control for a stereo model

1. Four vertical control points, one near each corner of the model, are required.
2. Vertical control is determined by differential leveling or trigonometric leveling.

INFORMATION SHEET

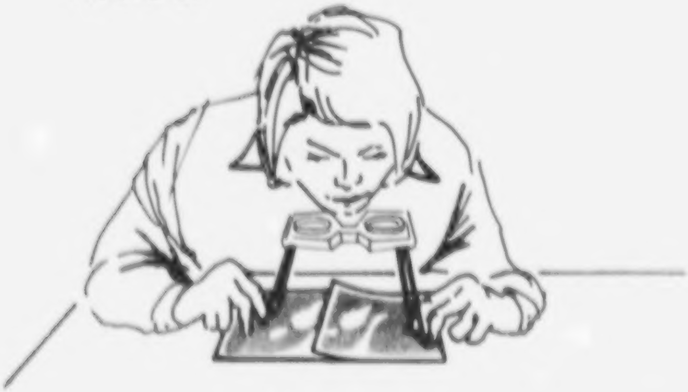
XXIV. **Steps for using the stereoscope**

A. Line up the adjoining aerial photographs with common features lined up.

(NOTE: Use one landmark to help line up the photos correctly.)

B. Slightly overlap the two photos and set the stereoscope on the photos straddling the overlap.

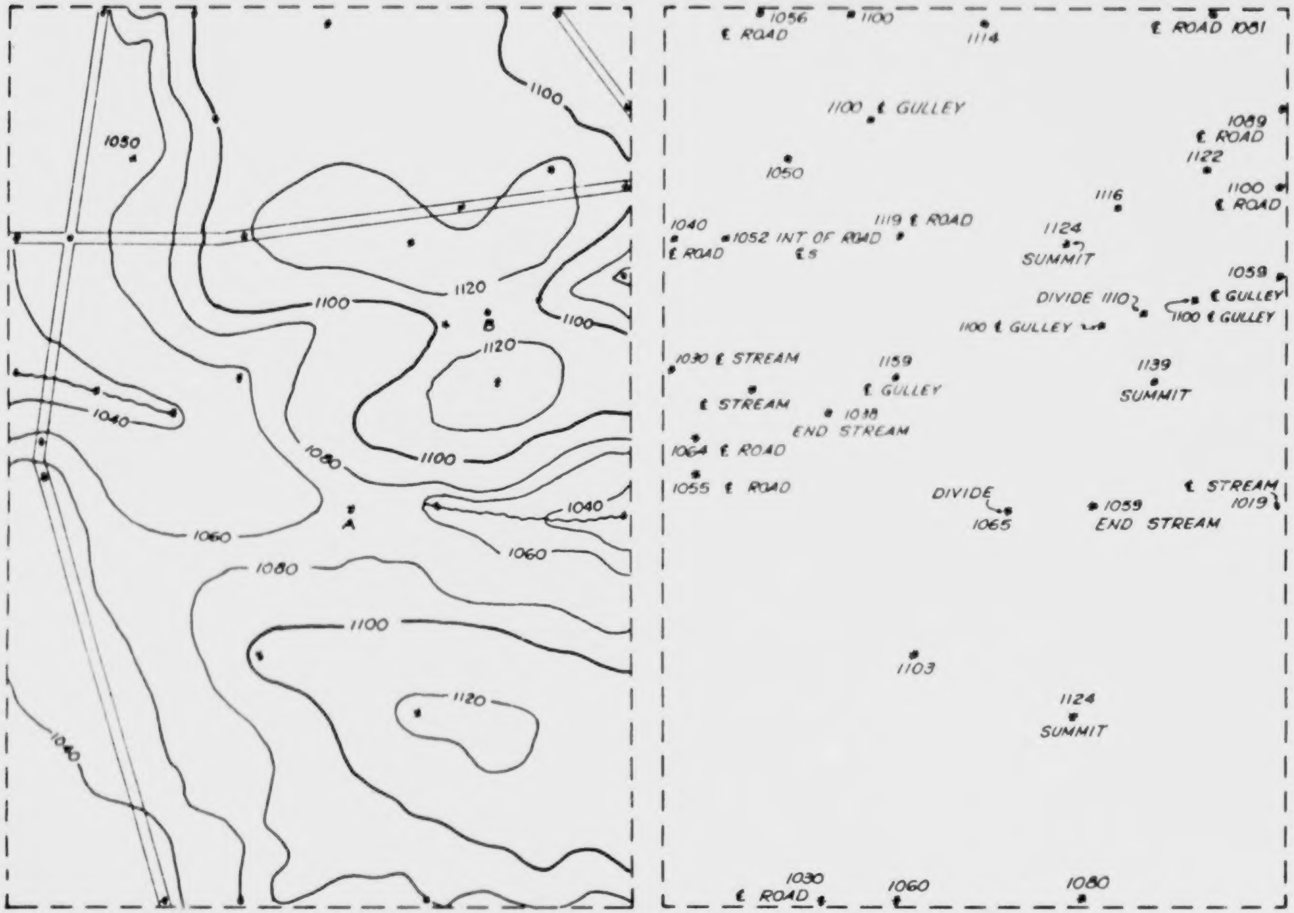
FIGURE 29



C. Look through the viewers and fix on the landmark. You should see two images of the landmark. (One appears to float.)

D. Maneuver the photo so the two images line up, one on top of the other. At this time you should see the photo images in three dimension (3-D).

Random Shot Method for Establishing Contours


1100
1050
1120
1100
1100
B
1120
1040
1080
1100
A
1040
1060
1060
1080
1100
1120
1040
1056
1100
℄ ROAD
1114
℄ ROAD 1081
1100 ℄ GULLEY
1089
℄ ROAD
1122
1050
1116
1100
℄ ROAD
1040
℄ ROAD
1052 INT OF ROAD
℄S
1119 ℄ ROAD
1124
SUMMIT
1059
℄ GULLEY
DIVIDE 1110
1100 ℄ GULLEY
1100 ℄ GULLEY
1030 ℄ STREAM
1159
℄ GULLEY
1139
SUMMIT
℄ STREAM
1038
END STREAM
1064 ℄ ROAD
1055 ℄ ROAD
DIVIDE
1065
1059
END STREAM
℄ STREAM
1019
1103
1124
SUMMIT
1030
℄ ROAD
1060
1080

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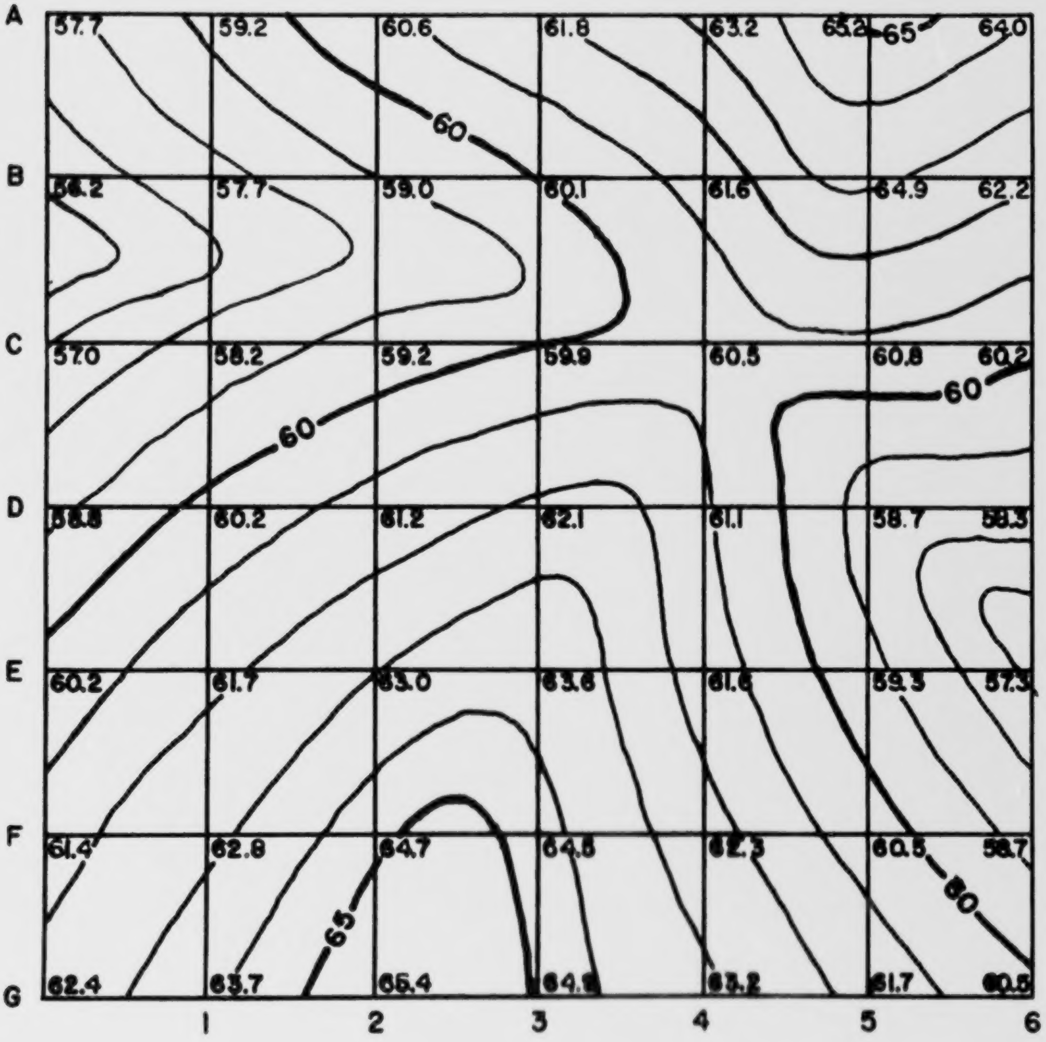
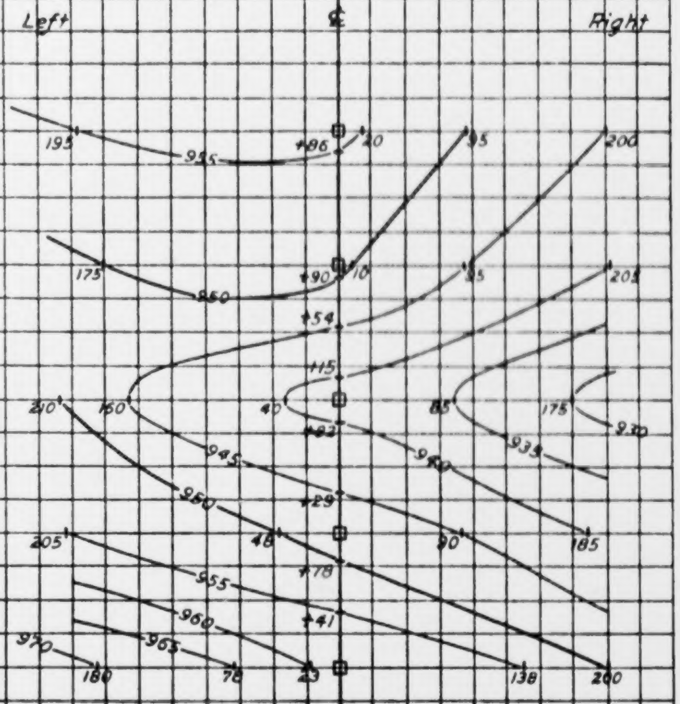
Grid Method for Establishing Contours


A
B
C
D
E
F
G
1
2
3
4
5
6
57.7
59.2
60.6
61.8
63.2
65.2
65
64.0
60
56.2
57.7
59.0
60.1
61.6
64.9
62.2
57.0
58.2
59.2
59.9
60.5
60.8
60.2
60
60
58.8
60.2
61.2
62.1
61.1
58.7
58.3
60.2
61.7
63.0
63.6
61.6
59.3
57.3
61.4
62.8
64.7
64.5
62.3
60.5
58.7
60
65
62.4
63.7
65.4
64.9
63.2
61.7
60.5

From *Map Drafting and Related Computations for Plane Surveying: Field Book.* Reprinted with permission of the Vocational Curriculum Development and Research Center, Natchitoches, Louisiana.

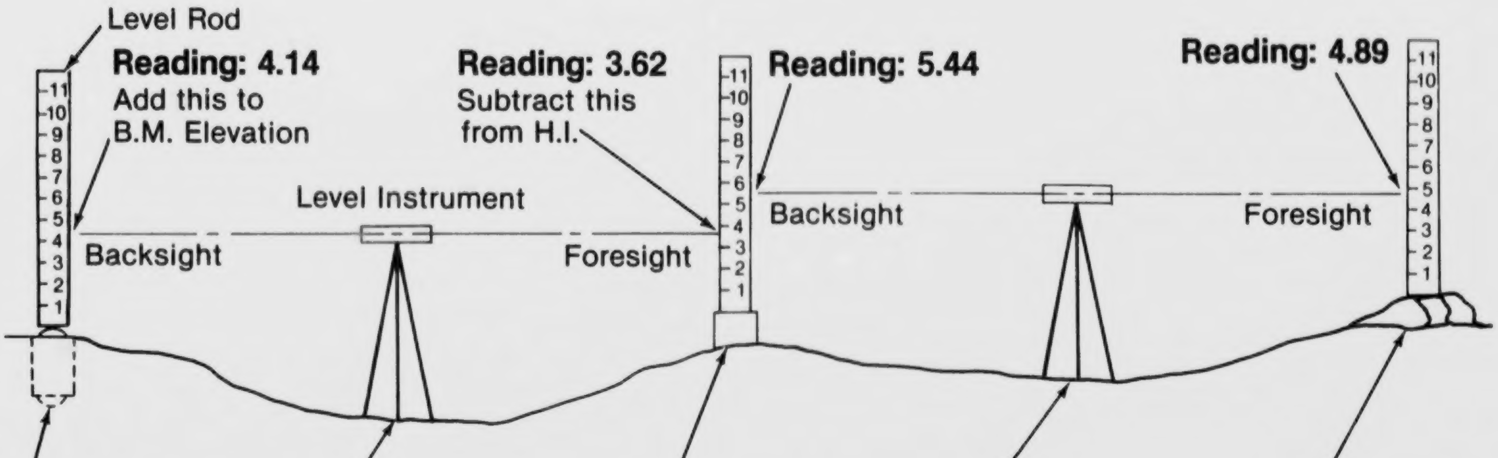
Cross Profile Method for Establishing Contours

Station	Elevation
109	956.8
108	950.7
107	938.4
106	948.6
105	958.7



Left
℄
Right
195
955
+86
20
95
200
175
950
+90
10
85
205
+54
+15
210
150
40
85
175
930
+93
945
940
935
+29
205
48
90
185
+78
955
960
+41
970
965
180
78
23
138
200

Leveling Procedure



Level Rod

Reading: 4.14
Add this to
B.M. Elevation

Backsight

Level Instrument

Reading: 3.62
Subtract this
from H.I.

Foresight

Reading: 5.44

Backsight

Reading: 4.89

Foresight

Elevation
1000.00′
USGS BM
Beginning Point

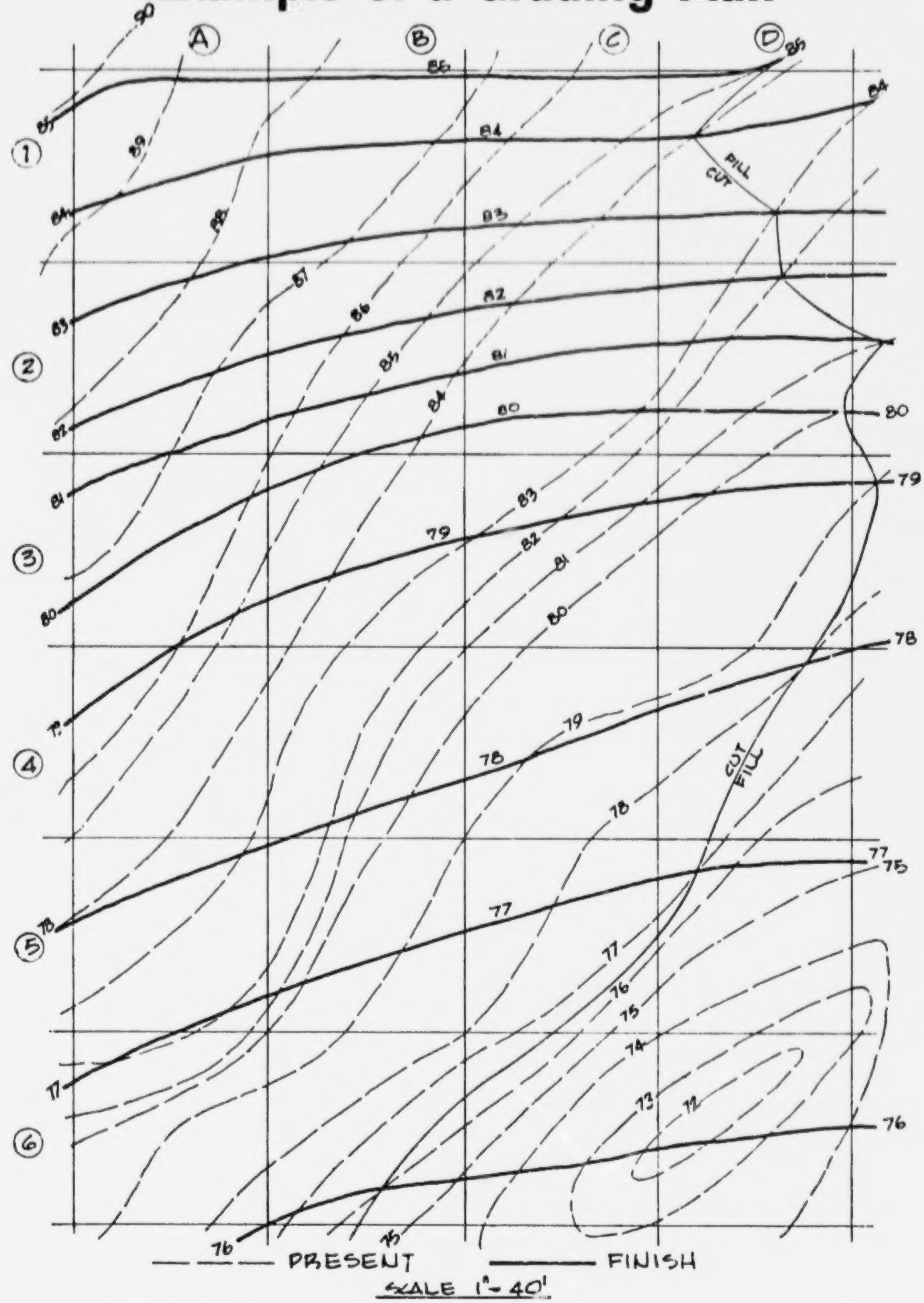
H.I. = 1000.00′
+ 4.14
1004.14′

TP1 = 1004.14′
− 3.62
1000.52′

H.I. = 1000.52′
+ 5.44
1005.96′

TP2 = 1005.96′
− 4.89
1001.07′

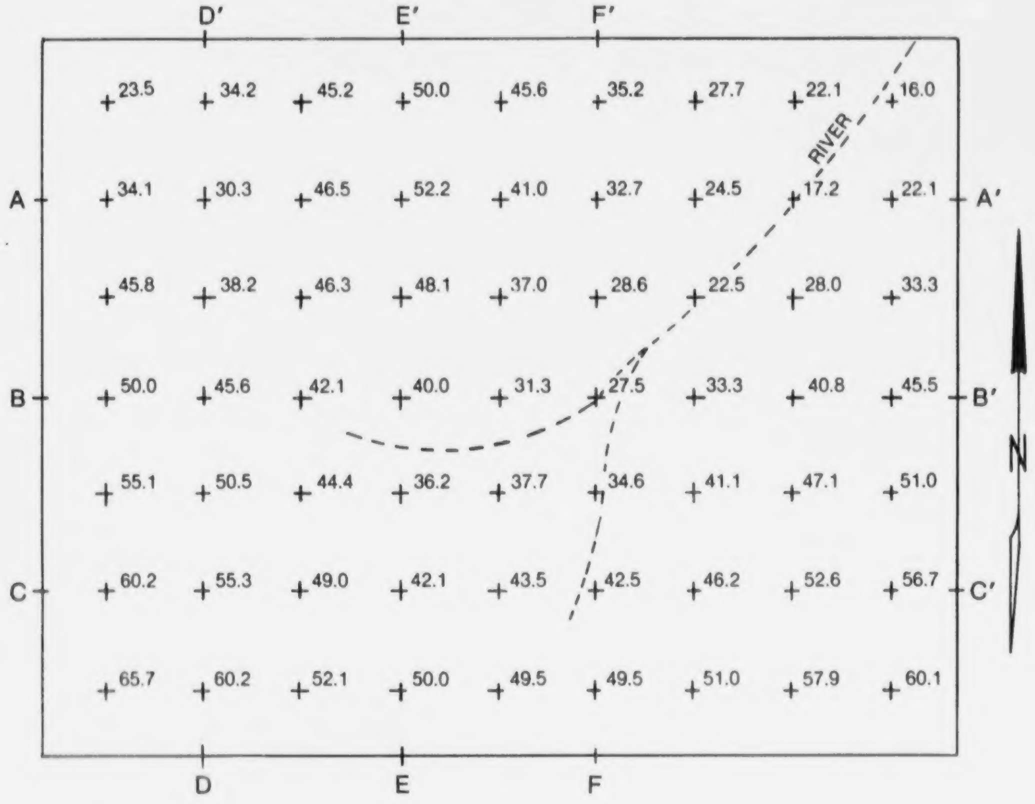
Example of a Grading Plan


A
B
C
D
1
2
3
4
5
6
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
FILL
CUT
CUT
FILL
PRESENT
FINISH
SCALE 1"-40'

TOPOGRAPHIC MAPPING
UNIT VIII

ASSIGNMENT SHEET #1 — INTERPOLATE CONTOURS FROM A GRID SURVEY AND PREPARE PROFILES FROM THE CONTOUR MAP

PART I — Interpolate contours from a grid survey


D'
E'
F'
A
A'
B
B'
C
C'
D
E
F
RIVER
N
23.5
34.2
45.2
50.0
45.6
35.2
27.7
22.1
16.0
34.1
30.3
46.5
52.2
41.0
32.7
24.5
17.2
22.1
45.8
38.2
46.3
48.1
37.0
28.6
22.5
28.0
33.3
50.0
45.6
42.1
40.0
31.3
27.5
33.3
40.8
45.5
55.1
50.5
44.4
36.2
37.7
34.6
41.1
47.1
51.0
60.2
55.3
49.0
42.1
43.5
42.5
46.2
52.6
56.7
65.7
60.2
52.1
50.0
49.5
49.5
51.0
57.9
60.1

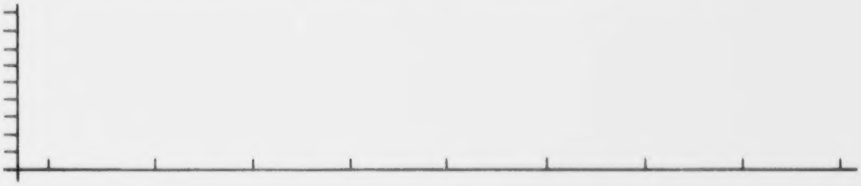
Given: Elevations plotted on a grid for a contour map. Horizontal scale: 1 in. = 20 ft.

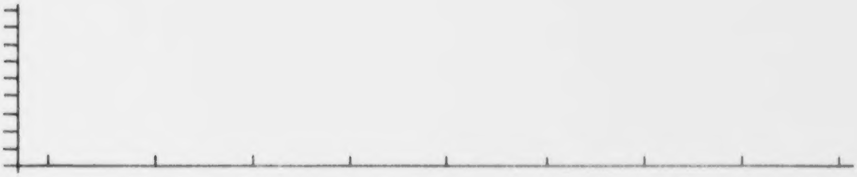
Complete the contour map above.
Use contour interval (CI) = 5 ft.
Label all contours.

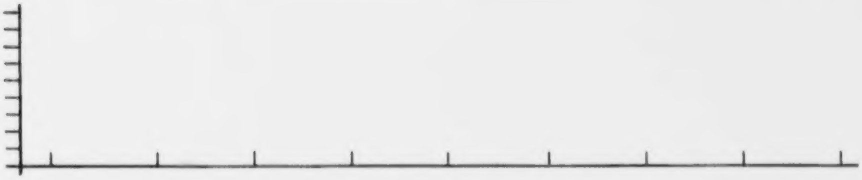
ASSIGNMENT SHEET #1

PART II — Plot the profiles that are indicated on the contour map in Part I. Plot A-A′ through F-F′.

Use horizontal scale: 1 in. = 20 ft, vertical scale: each given mark = 5 ft.
Label sections and elevation.







TOPOGRAPHIC MAPPING
UNIT VIII

ASSIGNMENT SHEET #2 — SET UP CONTOURS IN ISOMETRIC

Directions: Use the contour map that you completed in Assignment Sheet #1 for the final drawing.

Following instructions below, set up an area of topography into an isometric block.

Vertical scale: 1" = 10 ft
Horizontal scale: 1" = 20 ft

Given: Map view of required area to be placed in isometric block form.

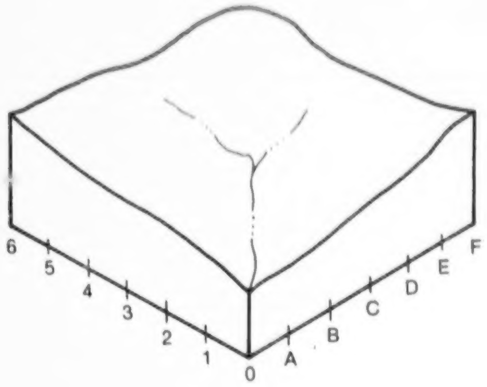
Required: 3 sheets tracing vellum

SHEET #1

You are given the contour interval, vertical and horizontal scales.

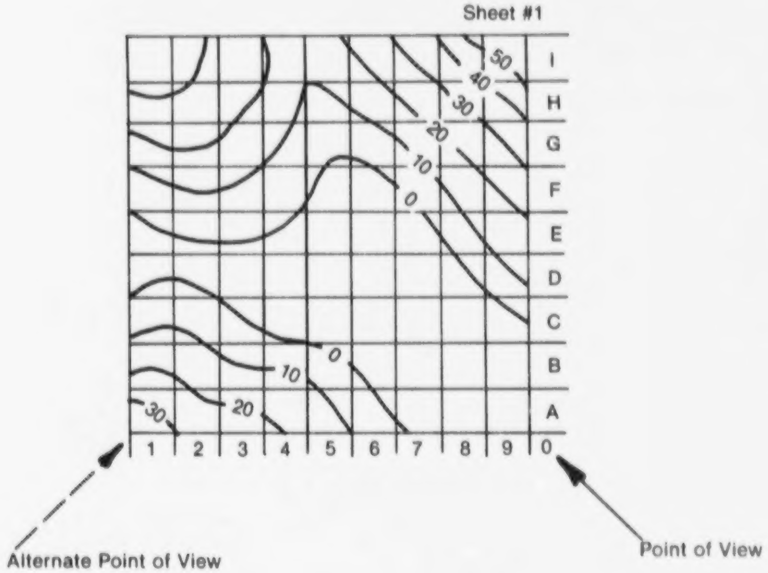
You have your map view of designated area with contour lines enclosed in a neat line.

Step I: Choose a point of view (that is the direction you wish to look into the block diagram).



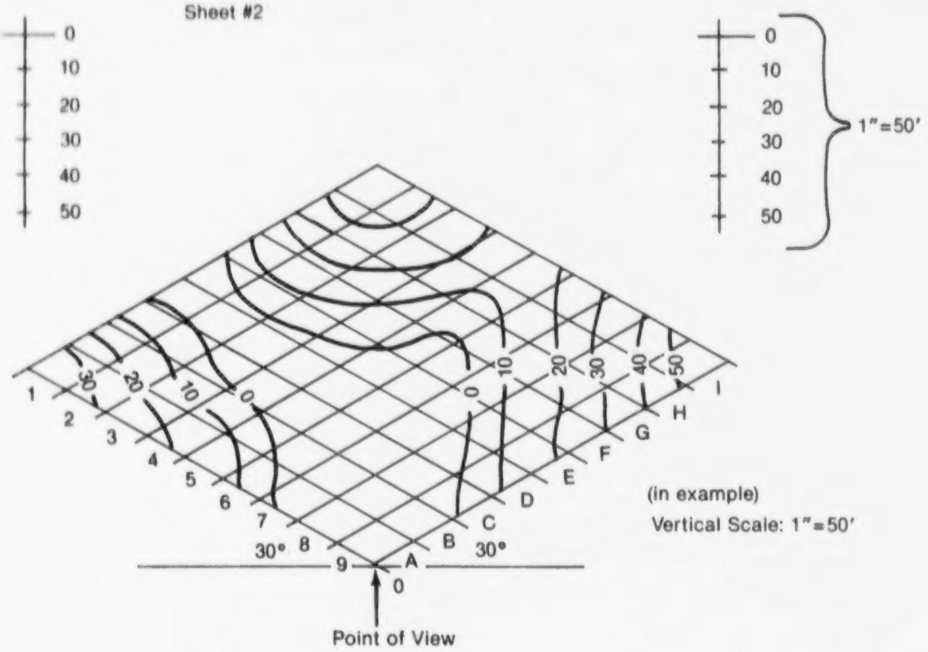
Point of View

ASSIGNMENT SHEET #2


Sheet #1
I
H
G
F
E
D
C
B
A
1
2
3
4
5
6
7
8
9
0
50
40
30
20
10
0
0
10
20
30
Alternate Point of View
Point of View

Step II: Set up a grid appropriate to the scale of the map.

Step III: Set up zone coordinates on grid using "0" as the location for point of view.


Sheet #2
0
10
20
30
40
50
0
10
20
30
40
50
1"=50'
1
2
3
4
5
6
7
8
9
30
20
10
0
0
10
20
30
40
50
A
B
C
D
E
F
G
H
I
30°
30°
0
Point of View
(in example)
Vertical Scale: 1"=50'

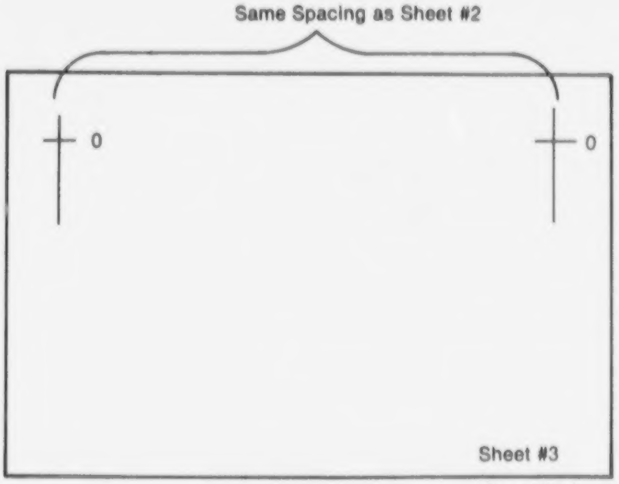
ASSIGNMENT SHEET #2

SHEET #2

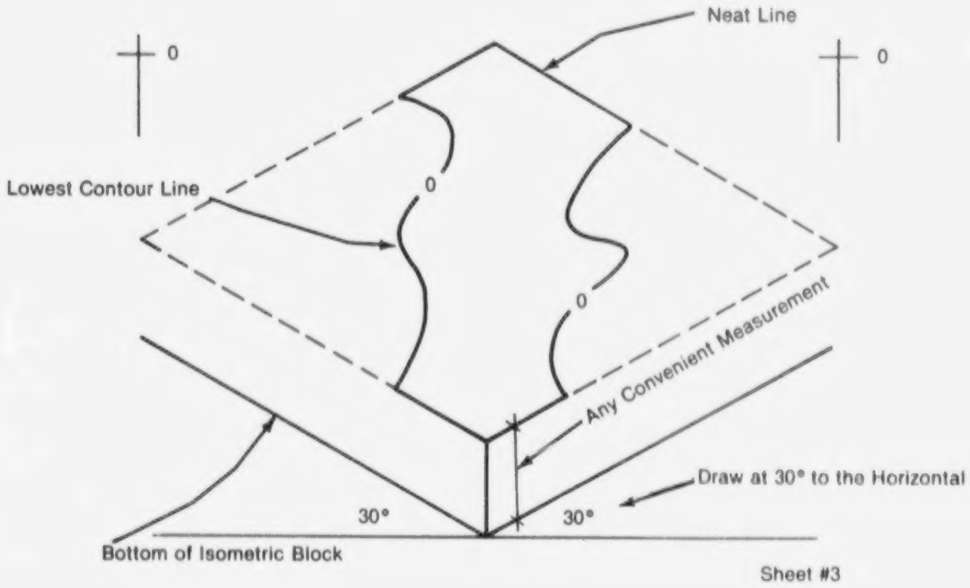
Step IV: On Sheet #2 draw in neat line at 30° to the horizontal.

Step V: Establish point of view, then place grid in and the zone coordinates in the appropriate position for the point of view.

Step VI: Next plot in location of contours (labeling contour interval). Use the grid to help you place contours in correct position.


Same Spacing as Sheet #2
0
0
Sheet #3

Step VIII-A


Neat Line
0
0
Lowest Contour Line
0
0
Any Convenient Measurement
Draw at 30° to the Horizontal
30°
30°
Bottom of Isometric Block
Sheet #3

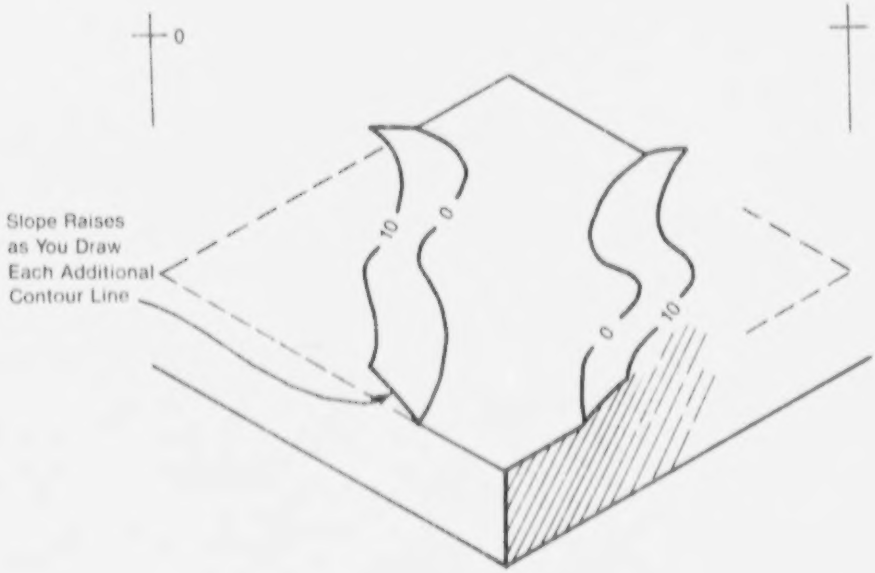
ASSIGNMENT SHEET #2

Step VII: Set up vertical scale on upper part of sheet as shown in example. The vertical scale is to show a mark for each contour interval.

Step VIII: Place your final drawing sheet (Sheet #3) over Sheet #2.

A. Trace off the part of the vertical scale as shown "0" mark.

B. Register "0" mark of vertical scale on Sheet #3 over "0" mark of vertical scale on Sheet #2. Trace off lowest contour interval line and neat line between lowest points on map.



Slope Raises as You Draw Each Additional Contour Line

C. Slide "0" mark down to next vertical measure on scale. Trace off next highest contour interval. Sketch in slope edge of block to form edge of contours. You are now starting to observe the formation of the shape of the land.

TOPOGRAPHIC MAPPING
UNIT VIII

ASSIGNMENT SHEET #3 — CALCULATE GRADES

Directions: Calculate the grade for the following situations.

	Elevation	Horizontal Distance
A.	from 690.0 to 697.0	13 feet
B.	from 935.5 to 885.5	27 feet
C.	from 50.2 to 59.9	7 feet
D.	from 234.5 to 277.6	257 feet
E.	from 356.0 to 234.4	375 feet

Show grade in percentages.

A. ____________________

B. ____________________

C. ____________________

D. ____________________

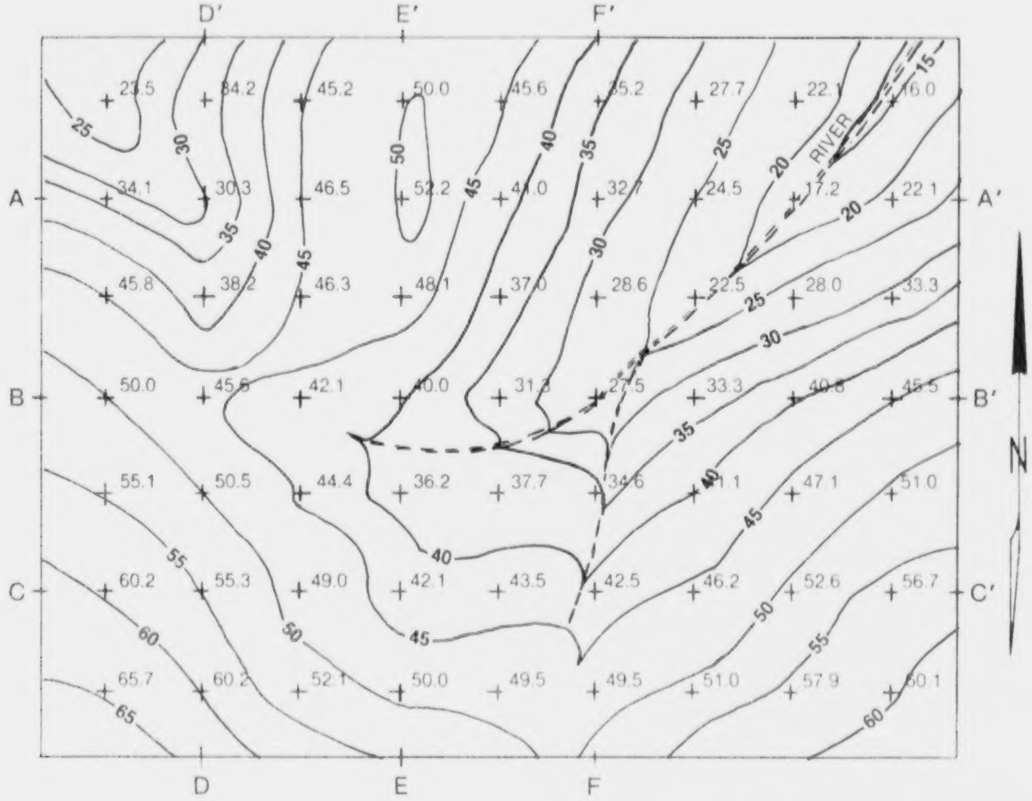
E. ____________________

TOPOGRAPHIC MAPPING
UNIT VIII

ANSWERS TO ASSIGNMENT SHEETS

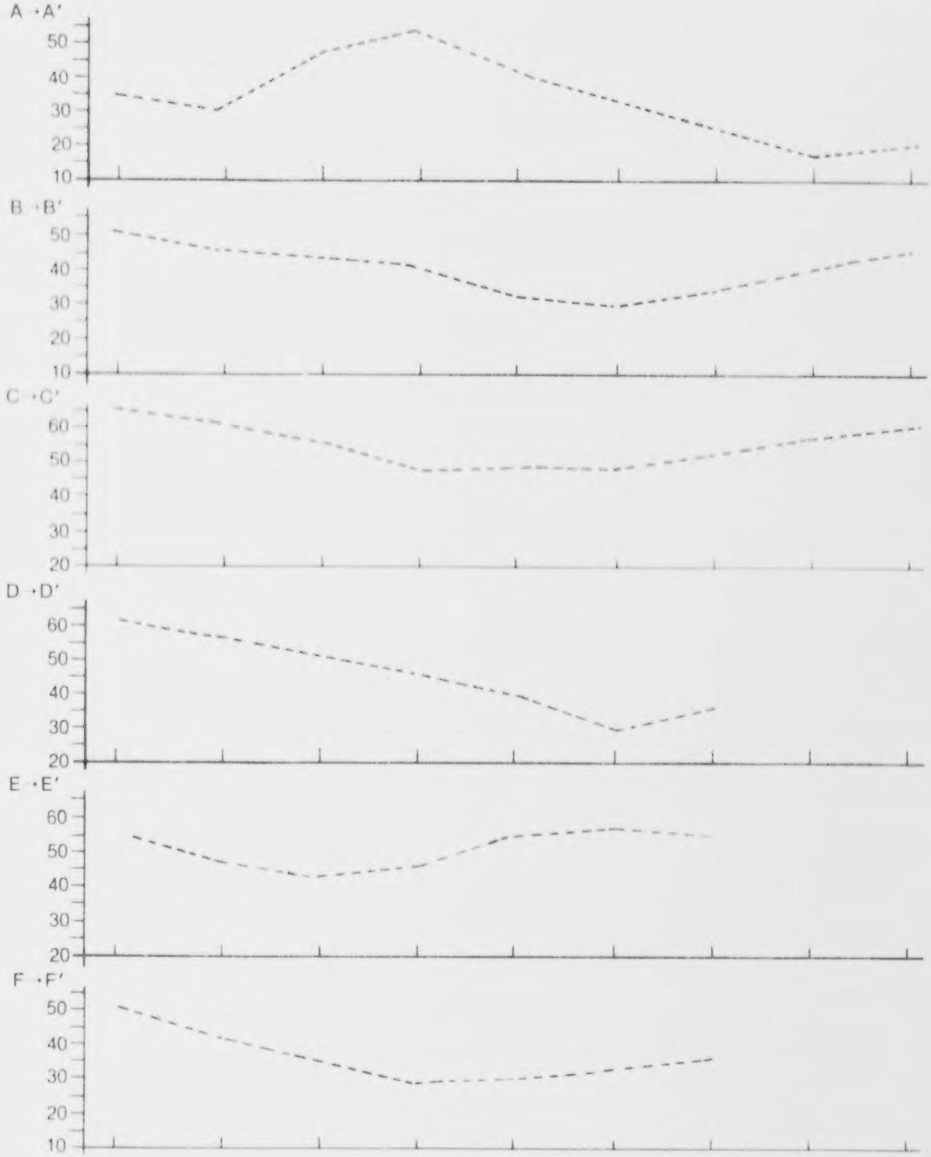
Assignment Sheet #1

PART I


D'
E'
F'
A
A'
B
B'
C
C'
D
E
F
N
RIVER
23.5
34.2
45.2
50.0
45.6
35.2
27.7
22.1
16.0
34.1
30.3
46.5
52.2
41.0
32.7
24.5
17.2
22.1
45.8
38.2
46.3
48.1
37.0
28.6
22.5
28.0
33.3
50.0
45.6
42.1
40.0
31.3
27.5
33.3
40.8
45.5
55.1
50.5
44.4
36.2
37.7
34.6
41.1
47.1
51.0
60.2
55.3
49.0
42.1
43.5
42.5
46.2
52.6
56.7
65.7
60.2
52.1
50.0
49.5
49.5
51.0
57.9
60.1
15
20
25
30
35
40
45
50
55
60
65

ANSWERS TO ASSIGNMENT SHEETS

PART II



ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2 — Evaluated to the satisfaction of the instructor

Assignment Sheet #3

A. 53%

B. 185%

C. 138%

D. 17%

E. 32%

TOPOGRAPHIC MAPPING
UNIT VIII

NAME ______________________

TEST

1. Match the terms on the right with the correct definitions.

______a. An established elevation of the ground or a road surface; the amount of incline or slope from the horizontal expressed usually in percentages

______b. A survey reading taken on a point of known elevation for the purpose of obtaining the height of the instrument; also called a plus (+) sight

______c. Any numerical or geometrical quantity or set of such quantities that serves as a reference or base for other quantities

______d. A point on a map or chart whose height above a specified reference datum is noted, usually be a dot or small "x" and elevation value

______e. Contour lines that are between index contours

______f. Represent half intervals between contour lines

______g. A pocket size stereoviewer consisting of two magnifying lenses in a metal frame that allows ease in viewing aerial photographs without having to use a stereoplotter

______h. A photograph taken from an airborne vehicle

______i. The rate of grade

______j. A line and symbol representation of natural and selected man-made features of a part of the earth's surface plotted to a definite scale; distinguishing characteristic is the portrayal of the shape and elevation of the terrain by contour lines

1. Aerial photograph
2. Backsight
3. Contour interpolation
4. Contour interval
5. Contour line
6. Cut and fill
7. Datum
8. Depression contour lines
9. Foresight
10. Grade

TEST

______k. Refers to distance and elevation measurements that have been obtained by surveying methods

______l. Indicate an elevation that represents a low place on the ground that has no surface drainage

______m. The vertical distance between the planes of consecutive contour lines, such as 5, 10, 20, 100, or 200

______n. A plan containing original ground contours over which contours of the highway, subdivision, or other embankment or excavation to be completed are superimposed on and connected with the original ground contours at the edge of construction limits

______o. A map that shows relief by conventions such as contours, hachures, shading, and tinting

______p. A road construction term that describes the quantities of earth removed from hillsides and filled into low spots

______q. Topographic datum line which is the level between high and low tide

______r. An imaginary line on the ground connecting all points that are the same elevation above or below sea level

______s. Every 5th contour line, which is numbered

______t. Determination of an intermediate value between field values from some known or assumed rate; estimating of contours

______u. The ability to see three-dimensionally using two views of a single object from two slightly different positions

______v. The science of obtaining measurements by means of photographs, usually aerial photographs

11. Gradient
12. Grading plan
13. Index contour line
14. Intermediate contour lines
15. Isometric map
16. Photogrammetric surveying
17. Sea level
18. Spot elevation
19. Stadia
20. Stereoplotter
21. Stereoscope
22. Stereoscopic model
23. Stereovision
24. Supplemental contour lines
25. Topographic map

TEST

_____w. A piece of equipment that allows the operator to view the stereo model in 3-dimension; from this model topographic and planimetric information can be traced out for future development of a map

_____x. A survey reading taken on a new point to determine its elevation; also called a minus (−) sight

_____y. The area covered by two overlapping or stereo pair of photos

2. List five uses of topographic maps.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

3. Match types of surveys used in topographic mapping listed on the right with the size of area to be mapped.

_____a.	Used for large scale maps of small areas less than 5 acres	1. Aerial survey
		2. Ground survey
_____b.	Used for mapping projects covering large areas more than 40 acres	

4. Select from the following list the field methods for obtaining topography by placing an "X" in the appropriate blanks.

_____a. Contours by hand level

_____b. Aerial method

_____c. Planetable method

_____d. Least squares method

_____e. Coordinate squares method

_____f. Radial method

_____g. Stadia method

_____h. Laser method

TEST

5. List four factors affecting the selection of the field method to be used for a topographic survey.

a. ____

b. ____

c. ____

d. ____

6. Distinguish between horizontal and vertical controls for topographic surveys by placing an "X" next to the description(s) of horizontal control.

______a. Is established by lines of levels starting from and closing on bench marks; elevations are established for all traverse hubs.

______b. Is established by traversing, triangulation, trilateration, and inertial and satellite methods depending on the size of the land area

______c. Is provided by two or more points on the ground, precisely fixed in position by distance and direction

7. Arrange in order the following steps in laying out a topographic survey by placing the correct sequence numbers (1-5) in the appropriate blanks.

______a. Calculate latitudes and departures, adjust traverse, and calculate coordinates.

______b. From the points located by the horizontal control traverse, make a survey locating all the details of features to be shown.

______c. Run an accurate closed traverse within the area to be mapped.

______d. Establish contours from vertical control.

______e. Using the coordinates, plot the traverse.

8. Match the methods used to establish contours on the right with the correct descriptions.

______a. Establishes horizontal and vertical control. Locates details by direction and distance from a control point. Stadia distance is recorded and vertical angle is read for each point; then horizontal distance and elevation are calculated. Contours can be drawn by interpolation or estimation connecting all points of equal elevation.

______b. The points on the ground are the elevation of the desired contour established by random shot method. Lines on the map are drawn connecting points of the same elevation.

1. Cross profile method
2. Grid method
3. Random shot method
4. Trace contour method

TEST

______c. The map is divided into a system of squares or rectangles. The elevations at the corners and critical points on the lines are located. The grid and elevations are plotted and the contours are then drawn by interpolation.

______d. Lines are run out at right angles to the traverse line. Contour points or elevations at changes in slope are established on these lines with their distances out from the traverse. Points are then plotted and points of equal elevation are joined by contour lines. This method is used for development of cross sections for transportation plans.

9. Complete the following statements concerning national standards for horizontal and vertical accuracy on topographic maps by circling the correct words.

   a. Horizontal accuracy — Requires no more than 10 percent of well-defined map points tested to be more than (1/10", 1/50") out of correct position at publication scales of 1:20,000 or smaller.

   b. Vertical accuracy — Requires that no more than 10 percent of the elevations of test points interpolated from contours be in error more than (1/2, 1/3, 1/10) the contour interval.

10. Complete the following chart of scale ratios used in the USGS topographic series.

TOPOGRAPHIC MAP SERIES

	Series	Scale	One inch Represents	Standard Quadrangle Size (latitude & longitude)	Quadrangle Area (square miles)
a.	7.5-minute	____________	2,000 feet	7.5 × 7.5 min.	49 to 71
b.	15-minute	1:62,500	____________	15 × 15 min.	197 to 282
c.	Intermediate-scale quadrangle	____________	over 1.5 miles	30 min. × 1°	1,145 to 2,167
d.	U.S. 1:250,000	1:250,000	about 4 miles	____________	4,580 to 8,669
e.	International Map of the World	____________	about 16 miles	4° × 6°	73,734 to 102,759

11. Select true statements concerning the selection of contour intervals by placing an "X" next to the true statements.

______a. The standard of accuracy required affects the selection of a contour interval.

______b. Rugged terrain requires a larger contour interval.

______c. If map scale is reduced, the contour interval is reduced.

TEST

______d. 10-foot and 100-foot intervals are rarely used.

______e. U.S.G.S. commonly uses 5 foot contour intervals.

______f. Defense Mapping Service (DMS) commonly uses 50 foot contour intervals.

______g. Common rule on contour intervals is not to show more than 1 contour per linear inch.

12. Complete the following statements concerning characteristics of contour lines by circling the correct words.

    a. A contour is a line, all points of which lie at equal (**elevations, distances from a bench mark**).

    b. Every contour closes upon itself (**within, without, within or without**) the limits of the map.

    c. A contour line closing within the limits of the map either indicates a summit or a (**river, depression**).

    d. Contours never cross each other, except in the case of a/an (**mountain, overhanging cliff**) or a cave, and then they must cross twice.

    e. On uniform slopes, contours are (**evenly, unevenly**) spaced.

    f. The sharpest bends in contours occur at their intersection with ridge and valley lines, which they cross at (**45°, right**) angles.

    g. Contours bend toward the (**upgrade, downgrade**) when crossing a valley or depression, and toward the (**upgrade, downgrade**) when crossing a ridge line.

    h. Contours crossing a railroad laid to an (**even, uneven**) grade will be spaced at equal intervals.

    i. Contour lines crossing a stream point (**upstream, downstream**) and form V's or U's.

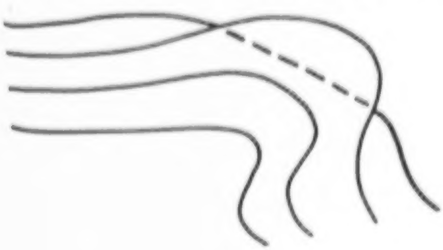
    j. Contour lines (**can, cannot**) run into the shore of a lake or other still body of water since the water is at the same level at all points.

    k. It is customary to make every fifth contour line (**dashed, heavier**) than the rest. The line is broken at some convenient place and the number representing the elevation is inserted. When contour lines are far apart, each one may be numbered.

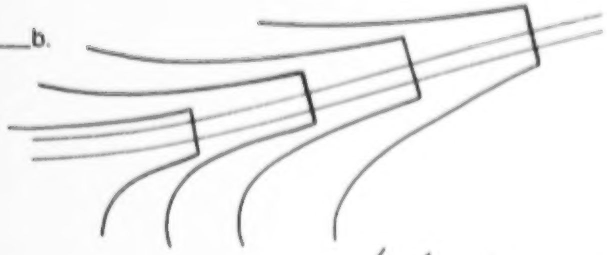
TEST

13. Match the contour line features on the right with their correct configurations.

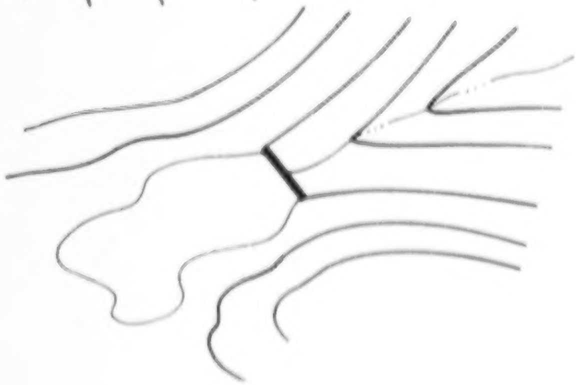
______a.



______b.

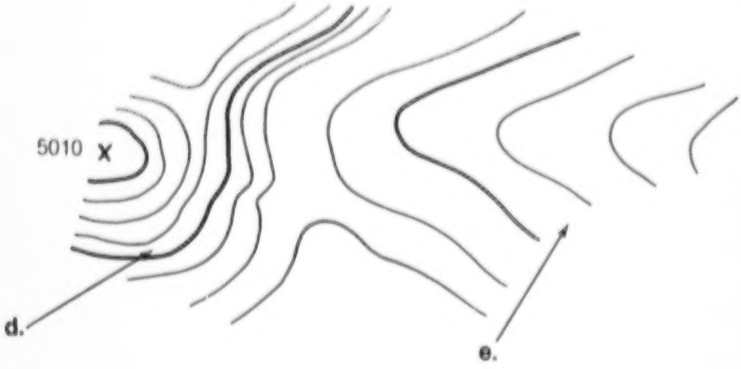


______c.



______d.

______e.

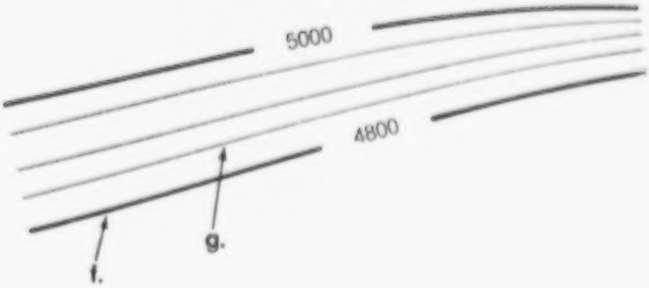


1. Stream
2. Embankment
3. Dam
4. Steep terrain
5. Flat terrain
6. Saddle
7. Depression contour
8. Overhang or cliff
9. Index contour
10. Intermediate contour

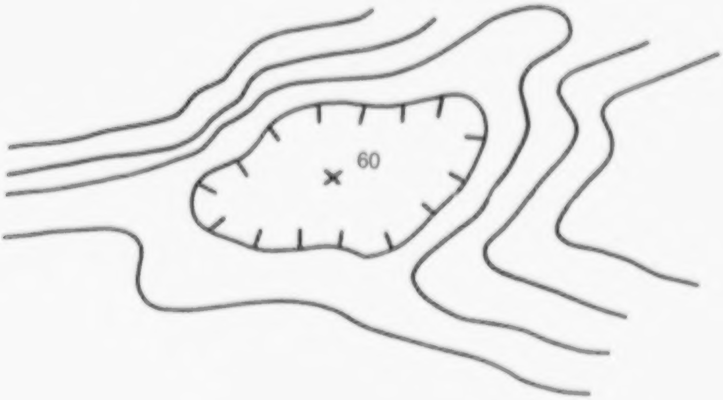
TEST

______f.

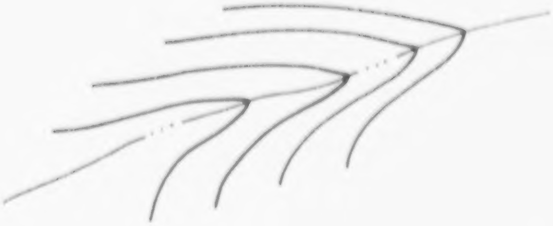
______g.


5000
4800
g.
f.

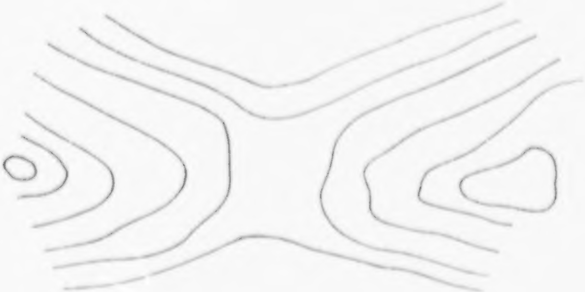
______h.



______i.



______j.



TEST

14. Select true statements concerning the common methods used to calculate area from a topographic map by placing an "X" next to the true statements.

_____a. The planimeter can be used to calculate area by tracing the boundary of the area in a counterclockwise direction.

_____b. The most common rule used to calculate the area of an irregular boundary is the Weston rule.

_____c. The equation for the trapezoidal rule is

$$A_T = W \left(\frac{h_1 + h_n}{2} + h_2 + h_3 + \ldots + h_{n-1}\right)$$

_____d. Simpson's rule uses the same formula as the trapezoidal rule.

_____e. Simpson's rule is designed to be used only for regular boundaries.

15. Arrange in order the steps in calculating cut and fill using the contour area method by placing the correct sequence numbers (1-6) in the appropriate blanks.

_____a. Bring out new contours where they differ from the old by interconnecting the points where the new contours rejoin the old ones.

_____b. Measure the shaded areas with a planimeter.

_____c. Make an earthwork diagram on the grading plan.

__6__d. Approximate the volume of the cut and fill by multiplying the contour interval by the sum of shaded areas.

_____e. Shade the areas between old and new contours at each level, using one color for cut and another for fill.

_____f. Draw boundary lines of no-cut, no fill.

TEST

16. Complete the following statements concerning the steps in developing and plotting a profile from profile leveling notes by placing the correct answers in the blanks provided.

______a. The beginning point is ____________.

1) Station 0+00

2) Station 1+00

3) BM 1

4) TP 1

______b. To obtain the elevation at Station 0+00, the level is set near Station 0+00, and a backsight is taken from the BM. The backsight is added to the elevation of the BM to give the ____________.

1) 2nd elevation

2) Foresight

3) HI

4) BM 2

______c. When you are finished, the calculations should be checked in the following manner:

1) Σ Foresights + Σ Backsights − Initial Elev. = Final Elev.

2) Initial Elev. + Σ Foresights + Σ Backsights = Final Elev.

3) Initial Elev. + Σ Backsights − Σ Foresights = Final Elev.

4) Initial Elev. + Σ Foresights − Σ Backsights = Final Elev.

17. Arrange in order the steps used to develop a profile from a contour map by placing the correct sequence numbers (1-6) in the appropriate blanks.

___3___a. The extremes of elevations are determined from the cutting plane line on the contour map.

______b. The projected points are connected with a smooth continuous line and any elevations or features are labeled.

______c. The location of the cross section cutting plane line is marked on the contour drawing.

______d. Contour map is placed above the profile grid.

TEST

_____e. The point of intersection of the cutting plane line and the contour line is projected to the profile.

_____f. Appropriate vertical scale is selected and is labeled on the profile paper with the elevations required.

18. List three methods for laying out contour lines.

a. ____________________

b. ____________________

c. ____________________

19. Select true statements concerning fixing a grade line by placing an "X" next to the true statements.

_____a. Ground profile is used as the basis of study to fix the grade location.

_____b. Factors that control grade include location of stream crossings, beginning and ending points, routes through towns and villages, and maximum rates of grade for the type of traffic using the highway or railway.

_____c. Grade is selected and fitted to the ground so as to allow a great deal of cut and fill.

_____d. The amount of dirt removed from the cuts should double the amount required to fill the low areas.

_____e. The gradient is found by dividing the amount of run by the horizontal distance.

_____f. The grade is found by multiplying the gradient by 10.

20. Complete the following statements concerning aerial photographs by filling in the blanks with the correct words.

a. Photographs may be taken from ____________.

b. Aerial photographs are taken in sequential order, usually with ____________ percent forward overlap and ____________ percent side overlap.

21. Distinguish between advantages and disadvantages of using aerial photography by placing an "A" next to the advantages and a "D" next to the disadvantages.

_____a. Cost of flying a project

_____b. Distortion around edges of aerial photos due to curvature of the earth

_____c. Access to areas difficult to reach by ground

_____d. Availability of aerial photos for all areas

_____e. Speed at which work is accomplished

TEST

22. Complete the following statements concerning applications of aerial photogrammetry by circling the correct words.

    a. (**Photo map, Photo mosaic**) is a composite of several aerial photos tied together to represent a large area.

    b. An orthophoto is an orthographic photograph that results from processing aerial photographs to remove (**fuzziness, distortions**).

    c. Analytical aerotriangulation produces coordinates of photo control points by (**mathematical, scientific**) procedures.

23. Select true statements concerning aerial photo control by placing an "X" next to the true statements.

    _____a. A baseline measurement of two clearly identified points from the ground within the model is required for horizontal control on a stereo model.

    _____b. Baseline measurements should be provided on every model.

    _____c. Eight vertical control points are required, two near each corner of the model.

24. Arrange in order the steps for using a stereoscope by placing the correct sequence numbers (1-4) in the appropriate blanks.

    _____a. Slightly overlap the two photos and set the stereoscope on the photos straddling the overlap.

    _____b. Maneuver the photo so the two images line up, one on top of the other. At this time you should see the photo images in three dimension (3-D).

    _____c. Line up the adjoining aerial photographs with common features lined up.

    _____d. Look through the viewers and fix on the landmark. You should see two images of the landmark. (One appears to float.)

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

25. Interpolate contours from a grid survey and prepare profiles from the contour map. (Assignment Sheet #1)

26. Set up contours in isometric. (Assignment Sheet #2)

27. Calculate grades in percents. (Assignment Sheet #3)

TOPOGRAPHIC MAPPING
UNIT VIII

ANSWERS TO TEST

1. a. 10
   b. 2
   c. 7
   d. 18
   e. 14
   f. 24
   g. 21
   h. 1
   i. 11
   j. 25
   k. 19
   l. 8
   m. 4
   n. 12
   o. 15
   p. 6
   q. 17
   r. 5
   s. 13
   t. 3
   u. 23
   v. 16
   w. 20
   x. 9
   y. 22

2. Any five of the following:
   a. As bases for other maps
   b. Planning highways
   c. Selecting airport sites
   d. Selecting industrial sites
   e. Routing pipelines and power lines
   f. Locating boundary lines for cadastral surveys
   g. Planning communication facilities
   h. Aiding in agricultural research
   i. Planning recreation areas
   j. Assessing and managing natural resources

3. a. 2
   b. 1

4. a, c, e, f, g

5. Any four of the following:
   a. Purpose of survey
   b. Map use (accuracy required)
   c. Map scale
   d. Contour interval
   e. Size and type of area involved
   f. Cost
   g. Equipment and time available
   h. Experience of survey personnel

6. b, c

7. a. 2
   b. 4
   c. 1
   d. 5
   e. 3

ANSWERS TO TEST

8. a. 3
   b. 4
   c. 2
   d. 1

9. a. 1/50"
   b. 1/2

10. a. 1:24,000
    b. about 1 mile
    c. 1:100,000
    d. 1° × 2°
    e. 1:1,000,000

11. a, b, f

12. a. Elevations
    b. Within or without
    c. Depression
    d. Overhanging cliff
    e. Evenly
    f. Right
    g. Upgrade, downgrade
    h. Even
    i. Upstream
    j. Cannot
    k. Heavier

13. a. 8 f. 9
    b. 2 g. 10
    c. 3 h. 7
    d. 4 i. 1
    e. 5 j. 6

14. c

15. a. 3
    b. 5
    c. 1
    d. 6
    e. 4
    f. 2

16. a. 1
    b. 3
    c. 3

17. a. 3
    b. 6
    c. 2
    d. 1
    e. 5
    f. 4

ANSWERS TO TEST

18. a. Random pattern plotting from stadia notes
    b. Radial pattern contouring
    c. Contouring from a grid pattern

19. a, b

20. a. Any one of the following: Airplanes, satellites, or ground stations
    b. 30-60, 10-30

21. a. D
    b. D
    c. A
    d. D
    e. A

22. a. Photo mosaic
    b. Distortions
    c. Mathematical

23. a

24. a. 2
    b. 4
    c. 1
    d. 3

25.-27. Evaluated to the satisfaction of the instructor

TRANSPORTATION MAPPING
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to layout open traverses by five different methods, plot a plan and profile for proposed road from field notes, and calculate area and volume for cross sections. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to transportation mapping with the correct definitions.
2. State the purpose of route surveys.
3. Select true statements concerning the fundamentals of a route survey.
4. Complete statements concerning superelevated roadways.
5. Identify elements of a horizontal circular curve.
6. Complete statements concerning mathematical formulas used for computing a horizontal curve.
7. Select true statements concerning circular curve layout by tangent offsets.
8. Complete statements concerning vertical curves.
9. Complete statements concerning plan views for route surveys.
10. Select true statements concerning characteristics of profiles for a route survey.
11. Select true statements concerning characteristics of cross sections for a route survey.

OBJECTIVE SHEET

12. Complete statements concerning field note reduction for a cross section.

13. Complete statements concerning plotting cross sections.

14. Distinguish between the methods used to determine areas of cross sections.

15. State the formulas for calculating earth volume.

16. List drawings included in a set of highway plans.

17. Select common horizontal and vertical scales used in transportation mapping for rural and urban areas.

18. List items that appear on a typical title sheet for a set of highway plans.

19. Select true statements concerning detail sheets.

20. Complete statements concerning the drafting of plan views, profiles, and cross sections.

21. Layout open traverses using several methods. (Assignment Sheet #1)

22. Layout a survey alignment for a road using bearings and coordinates. (Assignment Sheet #2)

23. Plot field notes for horizontal control, topography, profile, and cross section for a proposed road. (Assignment Sheet #3)

TRANSPORTATION MAPPING
UNIT IX

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Write to your state highway department and request a set of drafting standards.
2. Make a visit to an on-site project and observe cut and fill excavation.
3. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

A. Objective sheet

B. Information sheet

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

C. Transparency masters

1. TM 1 — Plotting a Traverse with Angles and Coordinates
2. TM 2 — Field Notes for a Simple Curve
3. TM 3 — Superelevations of a Roadway
4. TM 4 — Horizontal Curve
5. TM 5 — Vertical Curve
6. TM 6 — Example of a Plan and Profile
7. TM 7 — Example of Cross Sections
8. TM 8 — Field Notes for Cross Sections
9. TM 9 — Areas of Cross Sections
10. TM 10 — Typical Title Sheet
11. TM 11 — Example of a Highway Detail — Traffic Signal Plan
12. TM 12 — Typical Plan and Profile

D. Assignment sheets

1. Assignment Sheet #1 — Layout Open Traverses Using Several Methods
2. Assignment Sheet #2 — Layout a Survey Alignment for a Road Using Bearings and Coordinates
3. Assignment Sheet #3 — Plot Field Notes for Horizontal Control, Topography, Profile, and Cross Section for a Proposed Road

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. Madsen, David and Terence Shumaker. *Civil Drafting Technology.* Englewod Cliffs, NJ: Prentice-Hall, Inc., 1983.

B. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

REFERENCES USED IN DEVELOPING THIS UNIT

C. Steele, Robert. *Modern Topographic Drawing.* Houston, TX: Gulf Publishing Co., 1980.

D. *Map Drafting and Related Computations for Plane Surveying: Field Book.* Natchitoches, LA: Vocational Curriculum Development and Research Center, 1965.

E. *Surveying.* Sacramento, CA: California State Department of Education, 1966.

F. *Drafting Manual.* Colorado State Department of Highways, Denver, Colorado, February, 1980.

G. *Survey Manual.* Colorado State Department of Highways, Denver, Colorado, 1984.

H. ICS Staff & Clifton O. Carey. *Mapping.* Scranton, PA: International Textbook Co., 1937.

I. McCormac, Jack C. *Surveying Fundamentals.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

J. Wirshing, Roy and James Wirshing. *Civil Engineering Drafting.* New York: McGraw-Hill Book Co., 1983.

TRANSPORTATION MAPPING
UNIT IX

INFORMATION SHEET

I. **Terms and definitions**

A. Angle of repose — The slope of cut and fill from the road expressed in feet of horizontal run to feet of vertical run

B. Borrow pit — A pit or bank from which material is taken for use in filling or embanking

(NOTE: Borrow excavation is excavation from selected areas (borrow pits) outside the right-of-way. This is necessary when the roadway excavation does not supply sufficient suitable materials for construction of the embankment.)

C. Central angle — The intersection angle of a highway curve; also called the Delta (Δ) angle

D. Course — A line on a traverse

E. Curve length — The length of a highway curve from beginning to end measured along the arc

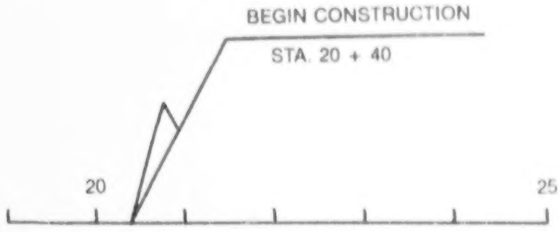
F. Deflection angle — In surveying an angle that veers to the right or left of a straight line, often the centerline of a highway, powerline, etc.

G. Degree of curve — The angle of a chord (from the preceding one) that connects station points along the centerline of a highway or railroad

H. Easement — A right acquired by public authority to use or control property for a designated purpose

I. Flag — A large one-sided arrow used for example to indicate the beginning and end of construction

FIGURE 1



J. Hub — A substantial square stake, usually drive in flush with the ground, with a tack marking the survey point

INFORMATION SHEET

K. Mass diagram — A drawing that shows the summary of earthwork over an entire project, including balance areas and quantities of earth grouped by soil classification, usually calculated by computer

L. Match line — The line at the edge of a mapped area which aids in fitting two drawings together

M. Offset line — A supplementary line close to and roughly parallel with a main line, to which it is referenced by measured offsets

N. Point of curve — The point at which a highway curve begins

O. Right-of-way — The legal right to cross the lands of another; used to indicate a strip of land for a road, railroad, or power line

P. Slope easement — An easement for cut and fill

Q. Subgrade — A portion of a roadbed prepared as a foundation for the base or surface course

R. Superelevation — Adjusting the slope perpendicular to centerline for the purpose of counteracting centrifugal force

S. Tangent — Straight line of a survey

T. Transit line — The centerline of a linear survey (highway, pipeline, etc.)

U. Vertical curve — The shape of a linear feature such as a road or highway (in profile) as it crests a hill or creates a sag in a valley or depression

II. **Purpose of route surveys** — For making studies for the location and construction of such public utilities as highway, railways, pipelines, canals, and power lines.

III. **Fundamentals of a route survey**

A. Conducted to obtain the following information:

1. Topography
2. Location of structures and objects
3. Establish the survey line of the ground

B. Most common use is for highway location and construction.

C. An open traverse survey is the general method used.

INFORMATION SHEET

D. Ground configuration is obtained by running cross lines to the traverse for obtaining elevations.

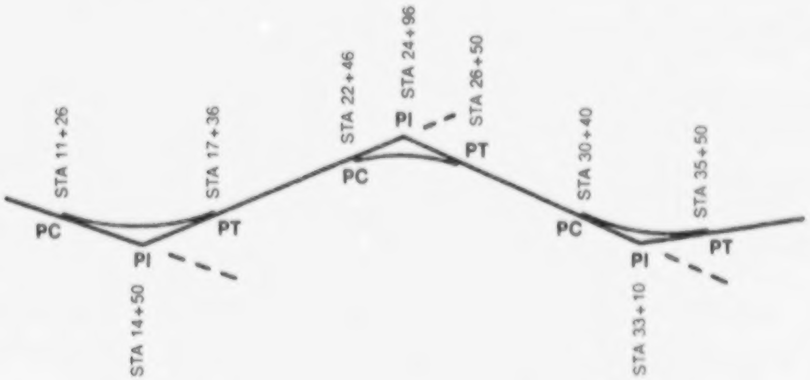
E. Open traverses can be plotted by angles or by coordinates. (Transparency 1)

(NOTE: Careful checking is necessary when plotting an open traverse since there is no check for accuracy by closing the traverse.)

F. Traverses are first staked out as a series of straight lines. (PI line)

G. Curves are employed at the points of change in the traverse to allow for flow of travel such as on a highway or railroad. (Figure 2)

FIGURE 2



H. Spiral curves are used to make the transition from a straight line to the circular curve more gradual.

I. Route surveying normally uses transits or theodolites.

J. The different steps in obtaining all the necessary field data are:

1. A transit party establishes all the horizontal control. (PI lines and curves)
2. The level party runs profile levels on the centerline of the survey.
3. Another crew follows and runs the levels on the cross line.

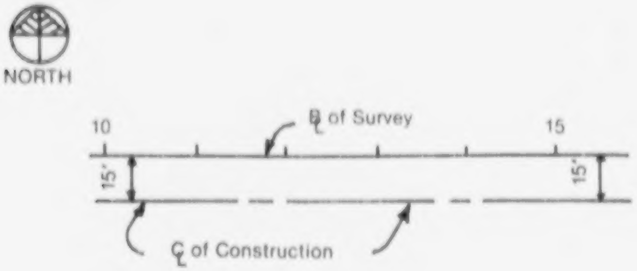
K. The open traverse, complete with curves, makes up the line for the survey alignment line.

INFORMATION SHEET

L. The survey alignment line may not be the final construction alignment, but must be a line that can be easily worked from.

M. When the construction centerline does not coincide with the survey centerline, complete alignment data and ties to the survey centerline must be provided.

FIGURE 3



N. Grade line, usually the centerline of a highway, is accurately established at 100 ft. stations, at beginning and ending points of curvature, and points of intersection of the back and forward tangents.

O. Points of intersection of the grade line with storm drains, utility lines, and cross streets are also carefully marked.

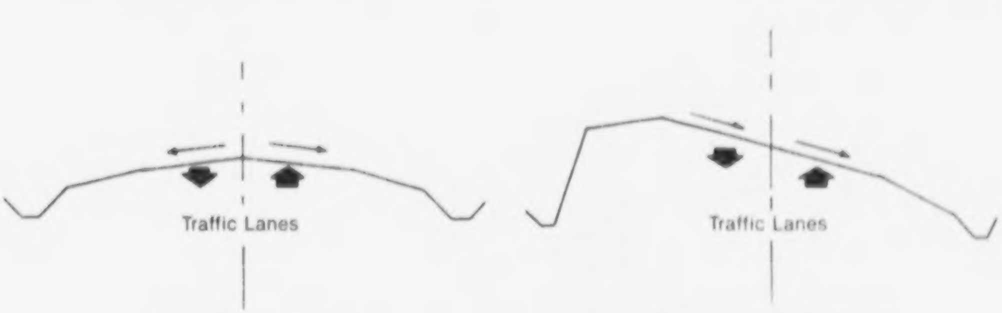
P. All survey information for bearings, distances, station points, and curve data must be recorded as field notes. (Transparency 2)

Q. The field notes are then used by the drafter to construct a complete set of maps.

IV. **Superelevations of a roadway** (Transparency 3)

A. A roadway is superelevated when the outside edge is higher than the inside edge; therefore, the road slopes from the outside to the inside of the curve.

FIGURE 4



Normal Roadway

Superelevated Roadway

INFORMATION SHEET

B. Purpose for superelevating a roadway is to allow for easy maneuvering of vehicles through horizontal curves.

V. **Elements of a horizontal circular curve** (Transparency 4)

R — Radius of the curve

PI — Point of intersection of the two tangents to the curve

I or Δ — The central angle subtended by a curve or the change in direction of two tangents

PC — Point of curvature — The point where the tangent "A" (see Figure 5) ends and the curve begins

PT — Point of tangency — The point where the curve ends and the tangent "B" begins

L — Length of curve from the PC to the PT

T — Tangent distance — The distance from PC to PI or PI to PT

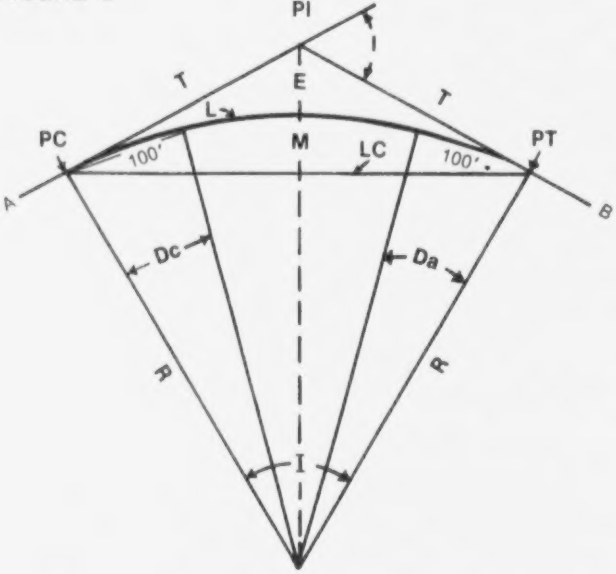
E — External distance — The distance from PI to the midpoint of the curve

LC — Long chord — The straight line distance from PC to PT

M — Middle ordinate — The distance from the midpoint of the curve to the midpoint of the long chord

D — Degree of curvature subtended by a 100′ chord (Dc) or 100′ arc (Da)

FIGURE 5



INFORMATION SHEET

VI. Mathematical formulas for computing horizontal curve

$\frac{D^\circ}{360^\circ} = \frac{100}{2\,\pi\,R}$ and $R = \frac{5729.58}{D}$ ft.

$T = R \cdot \tan \frac{I}{2}$

$L = 100\,\frac{I}{D}$ or $L = \frac{I}{360}\,(\pi \cdot \text{Dia})$

$R = T/\tan\,\frac{I}{2}$

$LC = 2 \cdot R\ \sin\,\frac{I}{2}$

$D^\circ a = \frac{5729.58}{R}$ or $\text{Sin}\ \frac{D^\circ c}{2} = \frac{50}{R}$

$E = R\left(1/\cos\frac{I}{2}\right) - 1$

$M = R \cdot \left(1 - \cos\frac{I}{2}\right)$

Example:

Given: Central angle $I = 38^\circ 40'$; tangent distance $T = 150.0$ feet.

Find:

1. Radius, R
2. Degree of curve, D
3. Length of curve, L

1. To find radius, R:

$R = T/\tan\ \frac{I}{2}$

$I = 38^\circ 40', \frac{I}{2} = 19^\circ 20'$

$\tan 19^\circ 20' = .35085$

$R = \frac{150.0}{.35085} = 427.53$ feet

INFORMATION SHEET

2. To find degree of curve, D:

$$\text{sine } {}^1\!/_2D = \frac{50}{R} = \frac{50}{427.53} = .11695$$

$${}^1\!/_2D = 6°43'$$

$$D = 13°26'$$

3. To find length of curve, L:

$$L = 100 \times \frac{38.66°}{13.43°} = 287.86 \text{ feet}$$

(NOTE: The length of curve may also be found by the formula L = RI, where the angle I is in radians. This length will be slightly longer and more precise, as it represents the true arc length.)

VII. Circular curve layout by tangent offsets

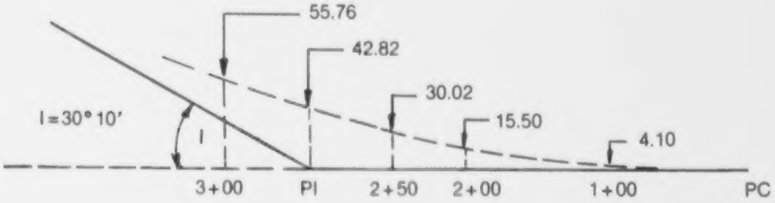
A. Used when precise layout of a curve is unnecessary.

Example: Small field ditch

B. PC, PT, and the external point are still located by transit method.

C. Tangent offsets are used to locate intermediate points on the curve.

FIGURE 6



Example (for Figure 6):

Given: I = 30°10′
D = 5°0′
T = 308.93
E = 40.90
L = 603.32

INFORMATION SHEET

Solution:

Distance from PC or PT (n)	Offset (z)
stations	feet
0	0
1+00	4.37
2+00	17.50
2+50	27.34

Measure the stations from the PC and PT along the tangents toward PI and offset at right angles the distances shown in the table. (See Figure 6). Since the tangent distance of this curve is slightly over 300 feet, the above points are adequate. Chain from the PC to determine the stationing of these stakes on the curve.

VIII. **Vertical curves** (Transparency 5)

A. Are the shapes of the road or highway as they crest a hill or reach the bottom of a valley.

B. Are used in highway and street vertical alignment to provide a gradual change between two adjacent grade lines.

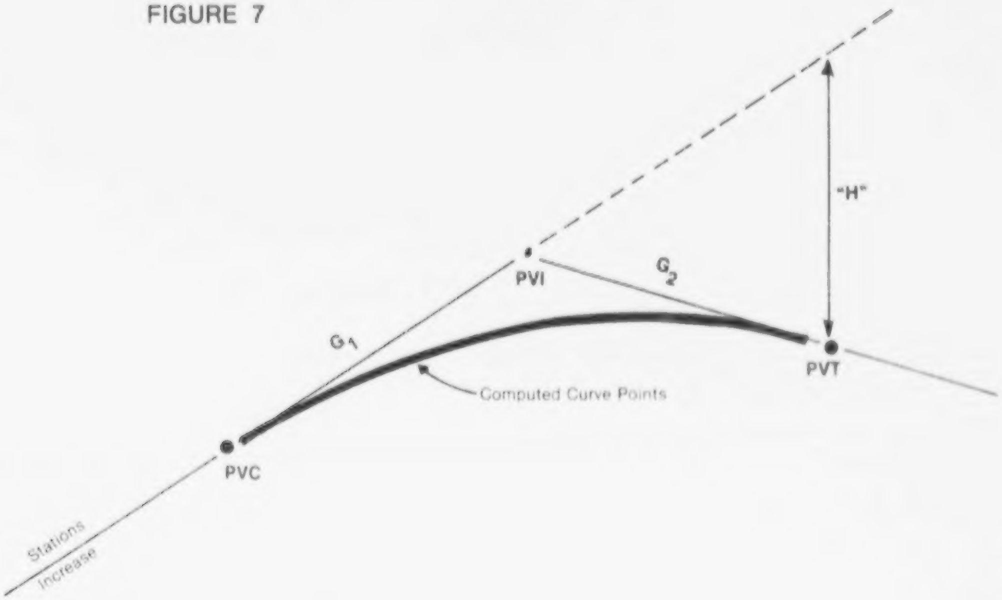
C. Are calculated and the elevation points are plotted by civil drafters.

D. The two general types are crests and sags.

INFORMATION SHEET

E. Elements of a simple vertical curve (Figure 7)

FIGURE 7


"H"
PVI
G_2
G_1
PVT
Computed Curve Points
PVC
Stations
Increase

P.V.C. = Point of vertical curvature
P.V.I. = Point of vertical intersection
P.V.T. = Point of vertical tangent
G_1 = Gradient or slope of back tangent
G_2 = Gradient or slope of fore tangent
H = Vertical distance from back tangent extended to the P.V.T.

IX. **Characteristics of plan views for route surveys** (Transparency 6)

A. Are constructed from field notes

B. Show the following:

1. Contours
2. Survey alignment (transit line)
3. Trees

INFORMATION SHEET

4. Buildings

   (NOTE: It is assumed all buildings will be removed from the right-of-way.)

5. Other roads

6. Cultivated areas

7. Station points

8. Curve (horizontal) data

9. All necessary horizontal control (bearings, distances, radii, and angles)

C. Are placed in the ungridded portion of the plan-profile paper.

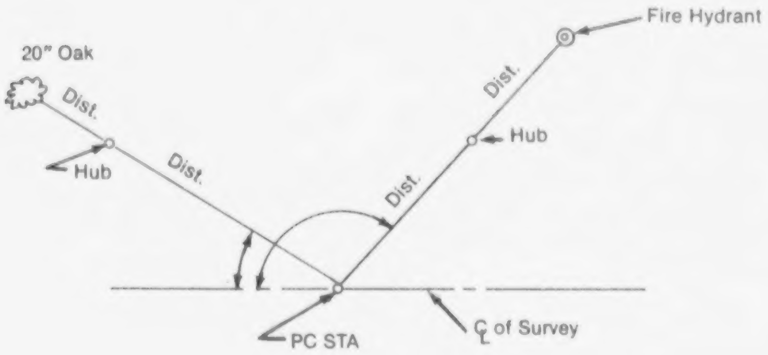
D. Sometimes many sheets of plan-profile paper are required for a route survey.

E. Each sheet contains 30 stations when the scale is 1" = 100 feet.

F. Each sheet should begin and end with match lines.

G. Reference points (a point on tangent station) are indicated by sketches or diagrams located away from the centerline.

FIGURE 8



INFORMATION SHEET

X. **Characteristics of profiles for a route survey**

A. Profiles are drawings showing vertical sections along a certain survey line.

B. Profiles are plotted from level notes or interpolated from the contour map.

C. Level notes show elevations along the survey line.

D. Profiles are plotted on standard plan-profile paper in the gridded portion. (Transparency 6)

E. The horizontal and vertical scales are commonly not the same scale.

F. Vertical scale is exaggerated because the horizontal distances are greater as compared to the change in elevation.

G. The preferred horizontal to vertical scale ratio is 10:1.

H. Horizontal axis is the same scale as plan view.

I. Only full stations are labeled and shown as tick marks on the accented grid lines.

J. First station should be set over one grid line from the vertical scale.

K. Station numbers increase from left to right.

L. Station limits of the profile must correspond exactly to those of the plan portion of the sheet.

M. Elevations for plotting profiles are obtained from the contour map in the plan view.

N. Elevation data are indicated on both left and right sides of the sheet.

O. Even elevaton numbers are placed on the inch line of the plan-profile sheet.

XI. **Characteristics of cross sections** (Transparency 7)

A. Represent a cut 90° to the profile line and are used to calculate the amount of earth to be cut or filled in a project.

B. Are usually plotted on 10 units to the inch cross-section paper.

C. Are arranged consecutively by stations which were reported in the field notes.

D. Are usually plotted from cross section field notes or profile notes that carry offset information on each side of the profile.

INFORMATION SHEET

E. Horizontal and vertical scales may or may not be the same.

F. The scales used depend on the accuracy required in computing the cross-sectional areas, upon the relief, and upon the size of the cross section paper.

G. Cross sections are taken from the center line out in each direction from the center line or taken out from the survey line of the street or borrow pit.

H. Spacing of cross sections is determined by the engineers — the closer together, the more accurate the estimation of volume.

I. Volume of fill between sections can be determined by averaging the end areas in the cross sections and multiplying this average by the distance between sections from beginning section to the last section.

J. Cut and fill areas can be cross hatched or shaded with the cut area shaded differently from the fill area.

XII. **Field note reduction for a cross section** (Transparency 8)

(NOTE: Refer to Transparency 8 while reading this explanation.)

A. Left hand sheet shows notes used in determining the height of the instrument.

B. Right hand sheet shows elevation points on which a reading was taken, the distance out from the control line and the rod reading.

C. The elevation was obtained by subtracting the rod reading from the height of instrument.

D. Only the distance and elevation are used in plotting the cross section.

XIII. **Plotting cross sections**

A. Each section is plotted individually beginning at the top and left-hand side of sheet with station 0+00.

B. Sections are then plotted under each other in order of station numbers.

C. Each point on the cross section is plotted by using a vertical scale for elevation and a horizontal scale for the distance out.

INFORMATION SHEET

D. Each point is labeled with coordinates. This coordinate number consists of a horizontal line with the distance out written on the bottom and the elevation written on the top.

Example:

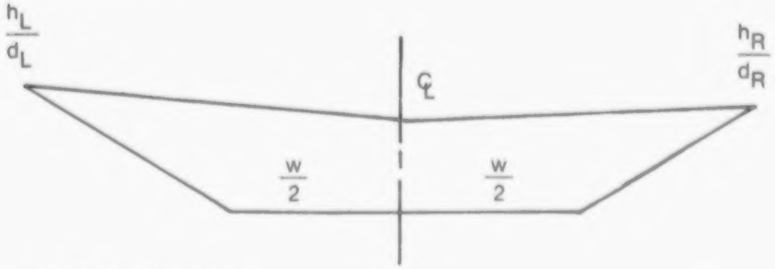
$\frac{60.8}{5}$ — elevation
— distance out from survey line

E. A vertical scale different from that of the horizontal is used to accent the elevation differentials.

XIV. **Methods used to determine areas of cross sections** (Transparency 9)

A. Three-level section (pure cut or fill)

FIGURE 9

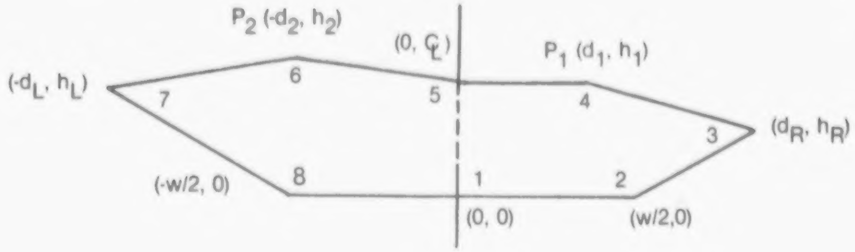

$\frac{h_L}{d_L}$
℄
$\frac{h_R}{d_R}$
$\frac{w}{2}$
$\frac{w}{2}$

W = Road Width

Area = (.5)[$^{w}/_{2}$ (h_L + h_R) + ℄ (d_L + d_R)]

B. Polygon section (pure cut or fill)

FIGURE 10


P_2 ($-d_2$, h_2)
(0, ℄)
P_1 (d_1, h_1)
($-d_L$, h_L)
7
6
5
4
3
(d_R, h_R)
(-w/2, 0)
8
1
2
(0, 0)
(w/2,0)

INFORMATION SHEET

General solution by coordinates:

$$2\ \text{area} = X_n(Y_{n+1} - Y_{Last} + X_{n+1}(Y_{n+2} - Y_n) + X_{n+2}(Y_{n+3} - Y_{n+1})$$

$$\ldots X_{Last}(Y_n - Y_{Last-1})$$

Area of Given X-section:

$$A = (.5)\ [{}^{w}/_{2}\ (h_R + h_L) + d_1(\text{℄} - h_R) + d_2(\text{℄} - h_L) + d_R h_1 + d_L h_2]$$

(NOTE: The absolute value of the area is shown because all areas are positive.)

C. Three level section (cut and fill mixed)

1. Triangle area on **left** side

FIGURE 11

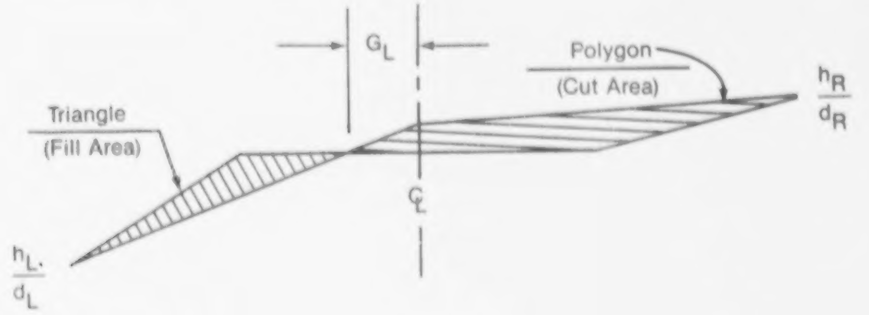
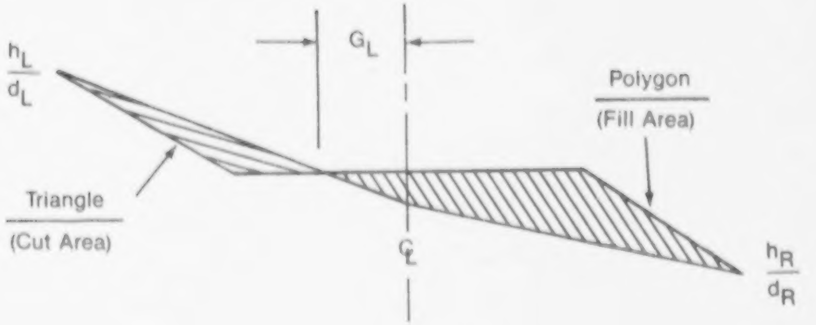

G_L
Polygon
(Cut Area)
h_R
d_R
Triangle
(Fill Area)
℄
h_L
d_L

FIGURE 12


G_L
h_L
d_L
Polygon
(Fill Area)
Triangle
(Cut Area)
℄
h_R
d_R

INFORMATION SHEET

Grade point (G_L)

$$G_L = \frac{\text{℄}\, d_L}{h_L + \text{℄}}$$

Triangle area

$$A_{\triangle} = (.5)\ {}^{w}/_{2}h_L - \frac{\text{℄}\, d_L h_L}{h_L + \text{℄}}$$

Polygon area

$$A_P = (.5)\ {}^{w}/_{2}h_R + \text{℄}\, d_R + \frac{\text{℄}^2 d_L}{h_L + \text{℄}}$$

2. Triangle area on **right** side

FIGURE 13

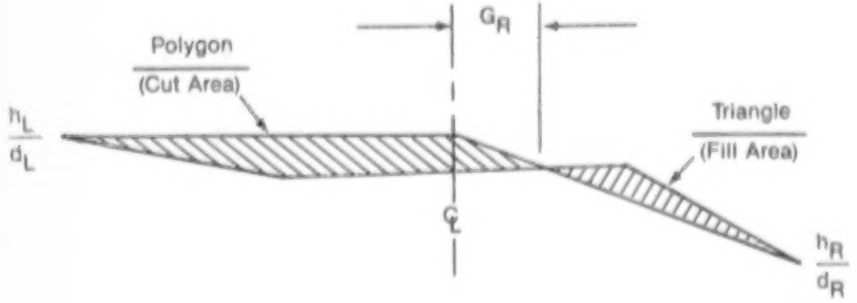
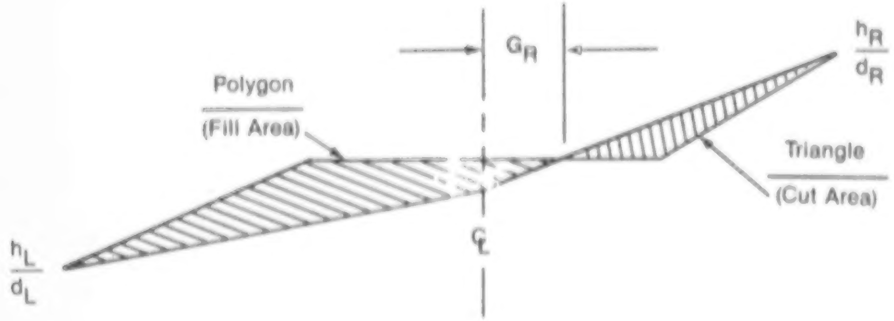

G_R
Polygon
(Cut Area)
$\frac{h_L}{d_L}$
Triangle
(Fill Area)
℄
$\frac{h_R}{d_R}$

FIGURE 14


G_R
$\frac{h_R}{d_R}$
Polygon
(Fill Area)
Triangle
(Cut Area)
℄
$\frac{h_L}{d_L}$

INFORMATION SHEET

Grade point (G_R)

$$G_R = \frac{\text{℄}\, d_R}{h_R + \text{℄}}$$

Triangle area

$$A_\triangle = (.5)\ {}^{w}/_{2} h_R - \frac{\text{℄}\, d_R h_R}{h_R + \text{℄}}$$

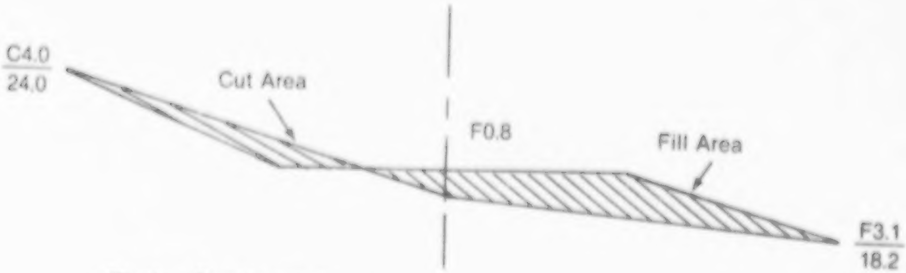
Polygon area

$$A_P = (.5)\ {}^{w}/_{2} h_L + \text{℄}\, d_L + \frac{\text{℄}^2 d_R}{h_R + \text{℄}}$$

Sample problem for Figure 15

FIGURE 15

W = 24 ft.



Find: Grade point
Area of cut and fill

Solution: Triangle is on left Use equation shown in C1.

1. Grade point (G_L)

$$G_L = \frac{\text{℄}\, d_L}{h_L + \text{℄}} = \frac{(.8)(24.0)}{4.0 + .8} = \mathbf{4.0\ ft.} \quad \leftarrow \text{Answer}$$

2. Triangle area

$$A_\triangle = (.5)\ \frac{w}{2} h_L - \frac{\text{℄}\, d_L h_L}{h_L + \text{℄}}$$

$$= (.5)\ \frac{(24)(4.0)}{2} - \frac{(.8)(24.0)(4.0)}{4.0 + .8} = \mathbf{16\ ft^2\ cut} \quad \leftarrow \text{Answer}$$

INFORMATION SHEET

3. Polygon area

$$A_P = (.5)\quad \frac{W}{2}h_R + \text{℄}d_R + \frac{\text{℄}^2 d_L}{h_L + \text{℄}}$$

$$= (.5)\quad \frac{(24)(3.1)}{2} + (.8)(18.2) + \frac{(.8)^2(24.0)}{4.0 + .8}$$

$= 27.48\ ft^2 =$ **$27\ ft^2$ fill** ← Answer

XV. Calculating earth volume

A. Volume by average end area

$$V_E = L\left(\frac{A_1 + A_2}{2}\right)$$

Where: V_E = Volume (cu. ft., cu. yd., cu. m.)
L = Distance between areas (ft., m.)
A_1A_2 = End areas (sq. ft., sq. m.)

B. Volume by prismoidal method

$V_P = {}^{L}/_{6}\,(A_1 + 4M + A_2)$

Where: V_P = Volume (cu. ft., cu. yd., cu. m.)
L = Distance between areas (ft. m.)
A_1A_2 = End areas (sq. ft., sq. m.)
M = Middle section (sq. ft., sq. m.)

C. Prismoidal correction

$V_C = V_E - V_P$

For 100 ft. length & 3 level section:

$V_C = 0.309\,(\text{℄}_1 - \text{℄}_2)\,[(d_{L1} + d_{R1}) - (d_{L2} + d_{R2})]$
= Negative correction in cu. yd.

INFORMATION SHEET

Example #1:

(NOTE: All cut volumes and all fill volumes are calculated separately.)

Given: STA	L	℄	R	AREA (sq. ft.)
115	$\frac{C4.0}{16.0}$	C6.0	$\frac{C12.0}{28.0}$	212
116	$\frac{C2.0}{13.0}$	C3.0	$\frac{C8.0}{22.0}$	102
W = 20 ft.				

Solution:

1. Volume by average end area:

$$V_e = L\left(\frac{A_1 + A_2}{2}\right) = 100\left(\frac{212 + 102}{2}\right)$$

$$= 15{,}700 \text{ cu. ft.} = \frac{15{,}700 \text{ ft}^3}{27 \text{ ft}^3/\text{yd}^3} = \mathbf{581 \text{ cu. yd.}} \qquad \leftarrow \text{Answer}$$

2. Volume by prismoidal method:

$$V_p = L/6\,(A_1 + 4M + A_2)$$

$$= 100/6\,(212 + 4M + 102)$$

M = Area calculated from average "L," "℄," and "R."

L_{AVG} = C4.0/16.0 + C2.0/13.0/2 = C3.0/14.5

℄$_{AVG}$ = C6.0 + C3.0/2 = C4.5

R_{AVG} = C12.0/28.0 + C8.0/22.0/2 = C10.0/25.0

$$M = (.5)[{}^{w}\!/_{2}(h_L + h_R) + \text{℄}(d_L + d_R)]$$

$$= (.5)[{}^{20}\!/_{2}(3.0 + 10.0) + 4.5(14.5 + 25.0)]$$

$$= 154 \text{ ft}^2$$

$$V_p = {}^{100}\!/_{6}\,(212 + 4\,(154) + 102) = 15{,}500 \text{ ft}^3$$

$$= \frac{15{,}500 \text{ ft}^3}{27 \text{ ft}^3/\text{yd}^3} = \mathbf{574 \text{ cu. yd.}} \qquad \leftarrow \text{Answer}$$

INFORMATION SHEET

3. Prismoidal correction

$$V_C = .309\,(℄_1 - ℄_2)[(d_{L1} + d_{R1}) - (d_{L2} + d_{R2})]$$

$$= .309\,(6.0 - 3.0)[(16.0 + 28.0) - (13.0 + 22.0)]$$

$$= 8.3 \text{ cu. yd.} = 8 \text{ cu. yd. (use)}$$

Check: $V_C = V_E - V_P = 581 - 574 = 7$
$V_P = V_E - V_C$
$= 581 - 7 = 574$ cu. yd.

Example #2:

Volume with sidehill sections

Given: STA	L	℄	R	AREA
108+00	$\frac{F2.3}{18.9}$	F3.5	$\frac{F1.3}{15.9}$	F83
108+50	$\frac{C3.1}{18.2}$	C0.8	$\frac{F4.0}{24.0}$	C28,F16
W = 24 ft.				

Find: Volume of cut & fill by average end area.

Solution:

1. Section changes from all fill to cut & fill.

2. Work fill as usual:

$$V_E = L\left(\frac{A_1 + A_2}{2}\right) = 50\left(\frac{83 + 16}{2}\right) = 2475 \text{ ft}^3$$

$$= \frac{2475 \text{ ft}^3}{27 \text{ ft}^3/\text{yd}^3} = \textbf{92 cu. yd. fill} \qquad \leftarrow \text{Answer}$$

3. For lack of more information assume the cut tapers out to zero at STA: 108+00, therefore use $A_1 = 0$ (cut).

$$V_E = L\left(\frac{A_1 + A_2}{2}\right) = 50\left(\frac{0 + 28}{2}\right) = 700 \text{ ft}^3$$

$$= \frac{700 \text{ ft}^3}{27 \text{ ft}^3/\text{yd}^3} = \textbf{26 cu. yd. cut} \qquad \leftarrow \text{Answer}$$

INFORMATION SHEET

XVI. **Standard set of plans for a highway project**

(NOTE: The order shown here is typical for a highway project, but may vary in your state.)

A. Title sheet

B. Typical section and general notes

C. Estimate quantities

D. Structure quantities sheets

E. Tabulation sheets

F. Detail sheets

G. Pit location sheets

H. Major structure detail sheets

I. Plan and profile sheets (line sheets)

J. Cross section sheets

K. Landscaping and sprinkler plans

L. Traffic control signs

M. Standard sheets

XVII. **Common scales used in transportation drawings**

A. Rural areas — 1″ = 100 ft. horizontal scale, 1″ = 10 ft. vertical scale

B. Urban areas — 1″ = 50 ft. horizontal scale, 1″ = 5 ft. vertical scale

XVIII. **Items on a title sheet for a set of highway plans** (Transparency 10)

A. Project number

B. State highway number

C. County and state

D. Location map — Shows

1. Project limits
2. Township and range
3. North arrow and bar graph

INFORMATION SHEET

4. Beginning and ending station
5. Major equations
6. Limits of previous projects
7. Major structure numbers (both existing and proposed)
8. Detour routes and no work sections
9. Railroad crossings, canals, streams, and rivers

E. Length and design data

F. Index of sheets

G. Approval blocks

(NOTE: Mechanical lettering is generally used on title sheets.)

XIX. **Detail sheets** (Transparency 11)

A. Show information necessary for constructing a special item.

B. Unrelated details may be shown on the same sheet as long as they are distinctly separated.

C. Details should be arranged in logical order.

D. Interchange details may have to be put on more than one sheet. Match lines are clearly marked on each sheet.

XX. **Drafting plan views, profiles, and cross sections**

A. Drafting of plan views (Transparency 12)

1. Show survey alignment as dashed
2. Show projected alignment as solid

   (NOTE: Line fonts will vary from agency to agency.)

3. Show curve points, stations and tick marks, bearings, and match lines.
4. Show tick marks on top of the alignment; every fifth mark going through the alignment and station is written near it.
5. Show bearings on top of tangent lines.
6. Do not repeat information from one sheet to the next.

INFORMATION SHEET

7. Begin and end the sheet on stations divisible by five.
8. Draw physical features in exact position and position labels, dimensions, notes, and other data for clarity.
9. Right-of-way area may require data for construction. Place other notes and data outside the right-of-way.
10. A suggested order for preparation of a plan sheet is
    a. Index block
    b. Basic control lines: center lines, radial lines, station tick marks, etc.
    c. Existing topography and walks, curbs, gutters, streams, buildings, shrubs, etc. Use light linework.
    d. Planned construction feature — roadways, drainage, substructures, etc. Use heavier linework.
    e. Lettering, labels, data, and notes — Curve data, equations, tangent bearings, land lines, general topography, street and road names, construction line designation, north arrow, construction notes, sheet references, and title.
11. Use the following suggested pen sizes for lines:
    a. Survey line — Pen no. 3
    b. Curve line — Pen no. 3
    c. Tangent portion — Pen no. 0
    d. Tick marks — Pen no. 1
    e. Topography — Pen no. 0 or finer
12. Show right-of-way (R/W) lines as long dash line, then two short lines.

B. Drafting of profiles (Transparency 12)

1. Show grades for the alignment to be constructed.
2. Correspond stations from the plan view.
3. Plot ground line under roadway profile grade as a dashed line or light thin line.
4. Show elevations to the hundredth of a foot.

INFORMATION SHEET

5. Show grades to the ten thousandth of a percent (grade percentage in ft./sta. or ft./100 ft.).

6. Arrange profile sheet with two inches left on bottom of sheet for the earthwork breakout.

7. Show the beginning and ending stations which tie to adjacent project.

8. Give bench mark data just below the margin of the profile strip or just above in the plan portion.

C. Drafting of cross sections

1. Note centerline of survey on the sheet.

2. Plot elevations and distances left and right of centerline.

3. Draw ground line.

4. Use roadway template for drawing profile grade and typical section applicable for each particular cross section station.

5. Draw in pencil to facilitate changes.

6. Note station number and ground elevation at centerline under each cross section.

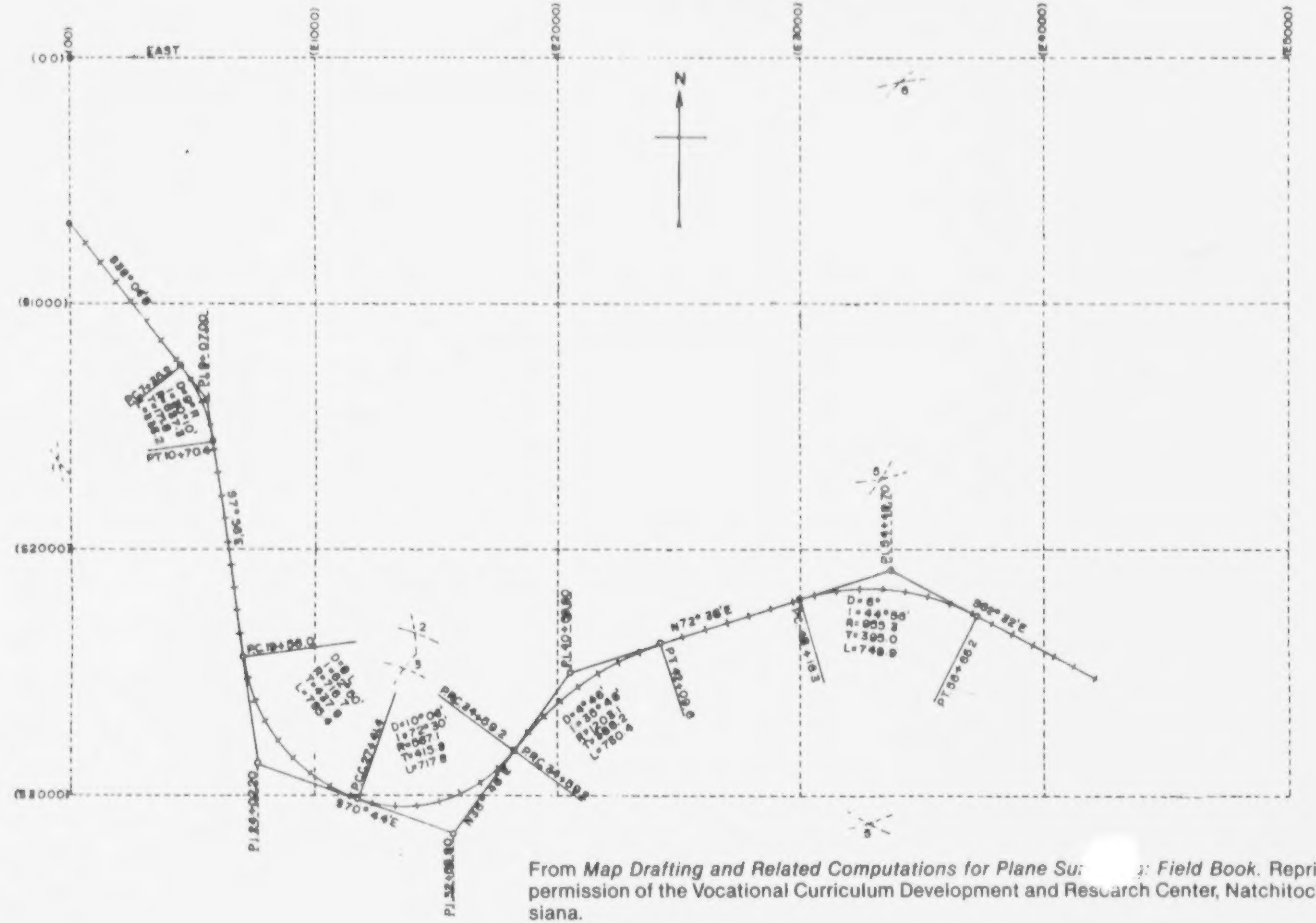
7. Note scale and type of cross section at the upper right corner of the sheet.

8. Write area of each section within the section and state if it is cut or fill.

9. Write volume of earth between the sections and state if it is cut or fill.

10. Connect first and last points of each section by a dashed line.

Plotting a Traverse With Angles and Coordinates


(0 0)
EAST
(E1000)
(E2000)
(E3000)
(E4000)
(E5000)
(S1000)
(S2000)
(S3000)
N
N72° 26'E
S70° 44'E
D=6°
I=44°56'
R=955.3
T=395.0
L=748.9
D=10°00'
T=415.9
L=717.8

From *Map Drafting and Related Computations for Plane Sur*[illegible]*: Field Book*. Reprinted with permission of the Vocational Curriculum Development and Research Center, Natchitoches, Louisiana.

Field Notes for a Simple Curve

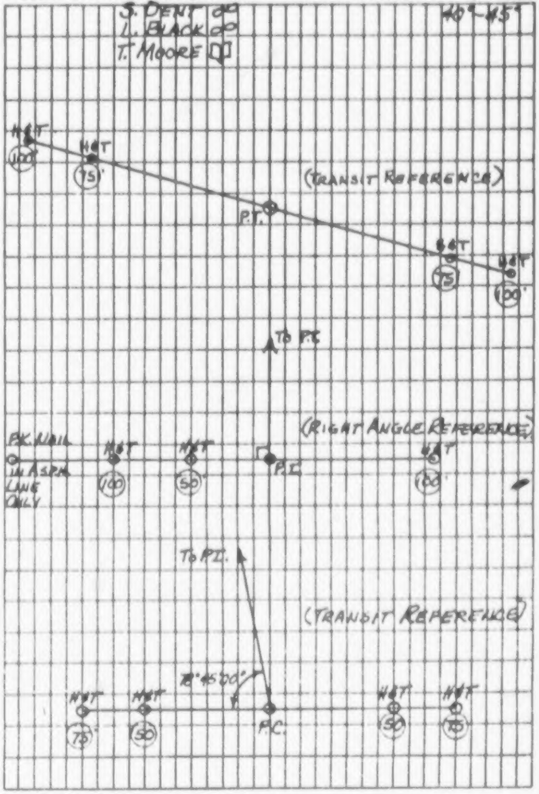
CURVE 1, RAMP A

STA.	POINT	DEFL.		CURVE DATA
$+65^{\underline{78}}$	P.T.	11°05'47"		
+50		10°27'55"		
696+00		8°27'55"		
			Δ=	22°11'35" LT.
+50		6°27'55"	D=	8°00'00"
			T=	140.47'
$+28^{\underline{84}}$	P.I.		L=	277.41'
			R=	716.20'
695+00		4°27'55"		
+50		2°27'55"		
694+00		0°27'55"		
$+88^{\underline{37}}$	P.C.	0°00'00"		

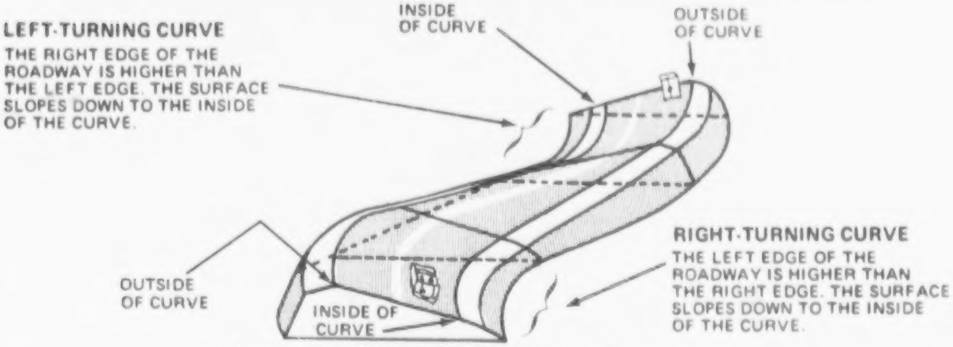
10.

Location
Crew G. WAITE ⊼
S. DENT ⚯
L. BLACK ⚯
T. MOORE ⌷

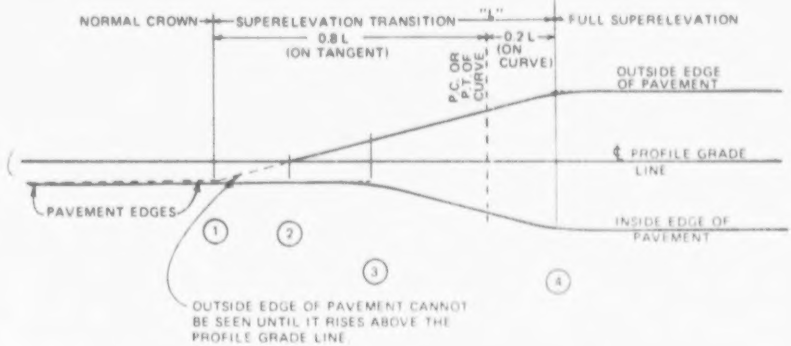
Date 4-20-83
Weather CLDY, FAIR
40°-45°


H&T
(100')
H&T
(75')
(TRANSIT REFERENCE)
P.T.
H&T
(75)
H&T
(100')
TO P.C.
(RIGHT ANGLE REFERENCE)
P.K. NAIL
IN ASPH.
LANE
ONLY
H&T
(100)
H&T
(50)
P.I.
H&T
(100')
TO P.I.
(TRANSIT REFERENCE)
78°45'00"
H&T
(75')
H&T
(50)
P.C.
H&T
(50)
H&T
(75)

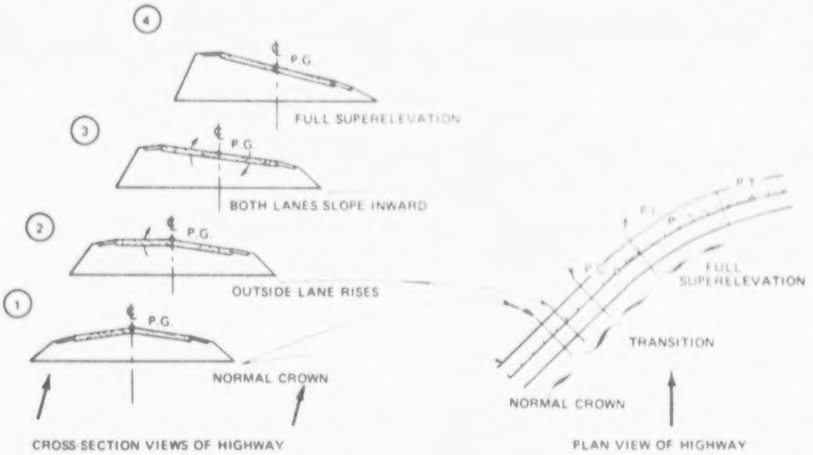
Superelevations of a Roadway


LEFT-TURNING CURVE
THE RIGHT EDGE OF THE ROADWAY IS HIGHER THAN THE LEFT EDGE. THE SURFACE SLOPES DOWN TO THE INSIDE OF THE CURVE.
INSIDE OF CURVE
OUTSIDE OF CURVE
RIGHT-TURNING CURVE
THE LEFT EDGE OF THE ROADWAY IS HIGHER THAN THE RIGHT EDGE. THE SURFACE SLOPES DOWN TO THE INSIDE OF THE CURVE.
OUTSIDE OF CURVE
INSIDE OF CURVE

Left- and Right-Turning Curves


NORMAL CROWN
SUPERELEVATION TRANSITION
"L"
FULL SUPERELEVATION
0.8 L (ON TANGENT)
0.2 L (ON CURVE)
P.C. OR P.T. OF CURVE
OUTSIDE EDGE OF PAVEMENT
℄ PROFILE GRADE LINE
INSIDE EDGE OF PAVEMENT
PAVEMENT EDGES
①
②
③
④
OUTSIDE EDGE OF PAVEMENT CANNOT BE SEEN UNTIL IT RISES ABOVE THE PROFILE GRADE LINE

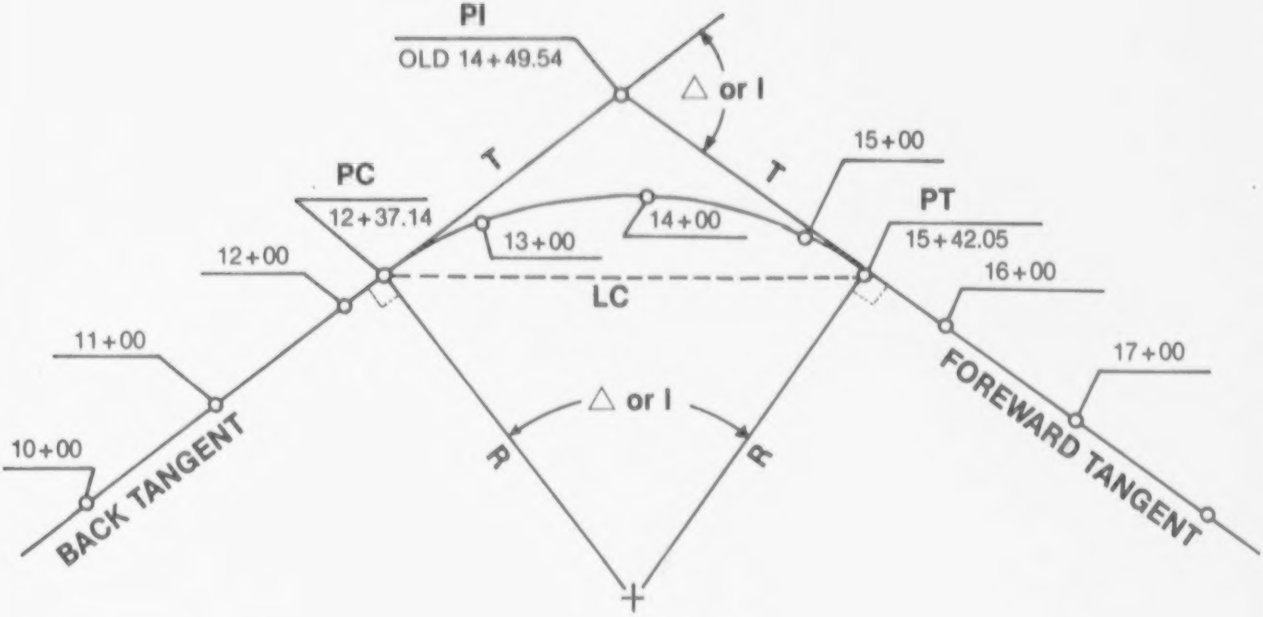
Profile View of a Superelevation Transition


④
℄
P.G.
FULL SUPERELEVATION
③
℄
P.G.
BOTH LANES SLOPE INWARD
②
℄
P.G.
OUTSIDE LANE RISES
①
℄
P.G.
NORMAL CROWN
CROSS-SECTION VIEWS OF HIGHWAY
P.T.
P.I.
P.C.
FULL SUPERELEVATION
TRANSITION
NORMAL CROWN
PLAN VIEW OF HIGHWAY

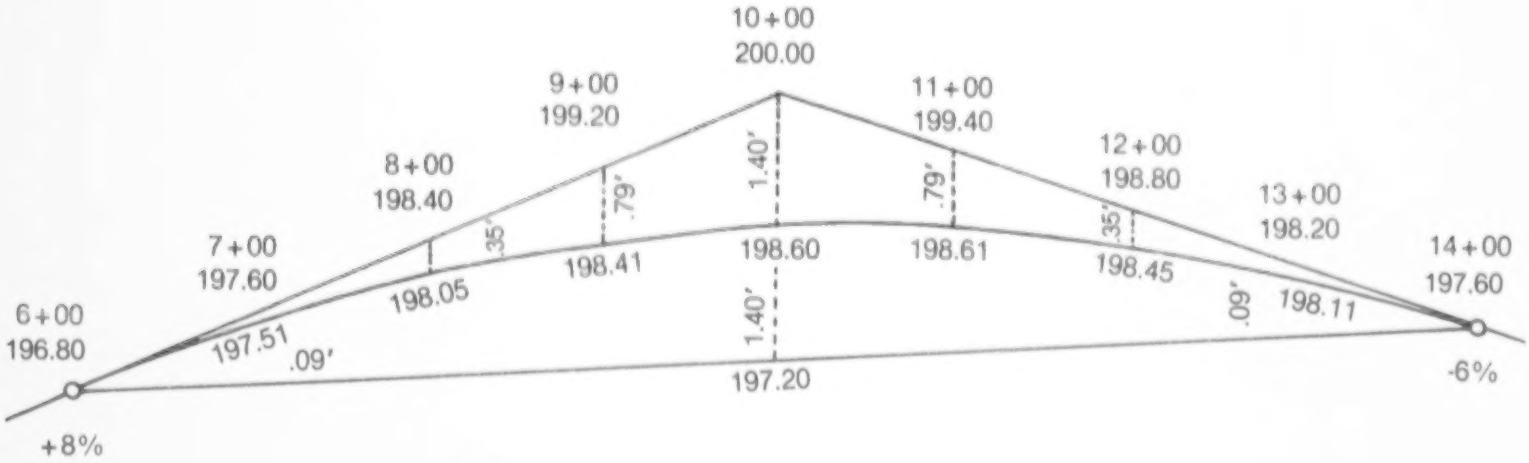
Cross-Section and Plan Views of a Highway in Superelevation

From *Civil Engineering: Drafting* by Roy and James Wirshing, © 1983. Reproduced with permission of McGraw-Hill Book Company.

Horizontal Curve

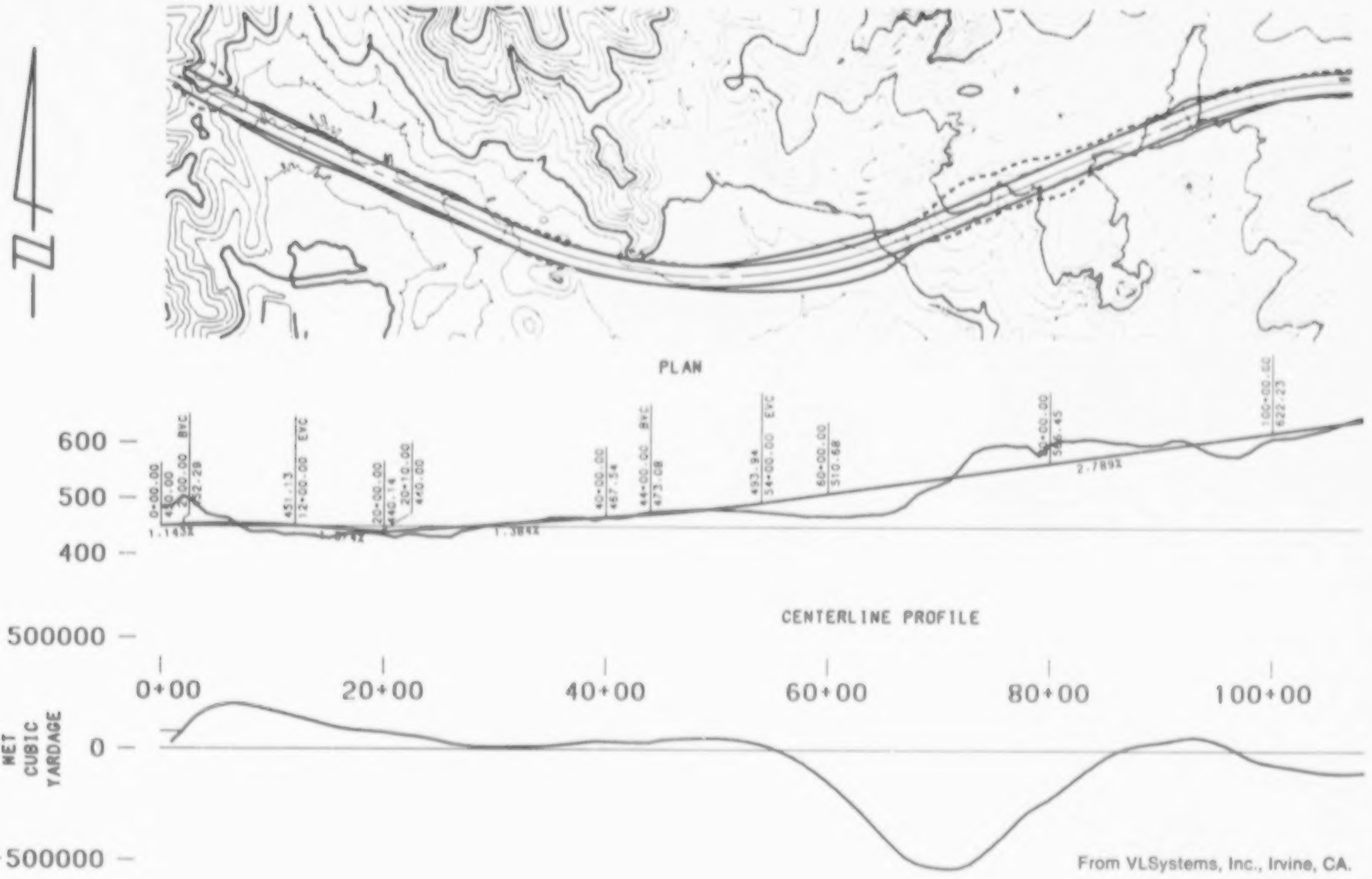

PI
OLD 14+49.54
△ or I
T
T
15+00
PC
12+37.14
PT
15+42.05
14+00
13+00
12+00
LC
16+00
11+00
17+00
△ or I
R
R
10+00
BACK TANGENT
FOREWARD TANGENT

Vertical Curve


10+00
200.00
9+00
199.20
11+00
199.40
8+00
198.40
12+00
198.80
13+00
198.20
7+00
197.60
14+00
197.60
6+00
196.80
1.40'
.79'
.79'
.35'
.35'
.09'
.09'
198.41
198.60
198.61
198.45
198.05
198.11
197.51
1.40'
197.20
-6%
+8%

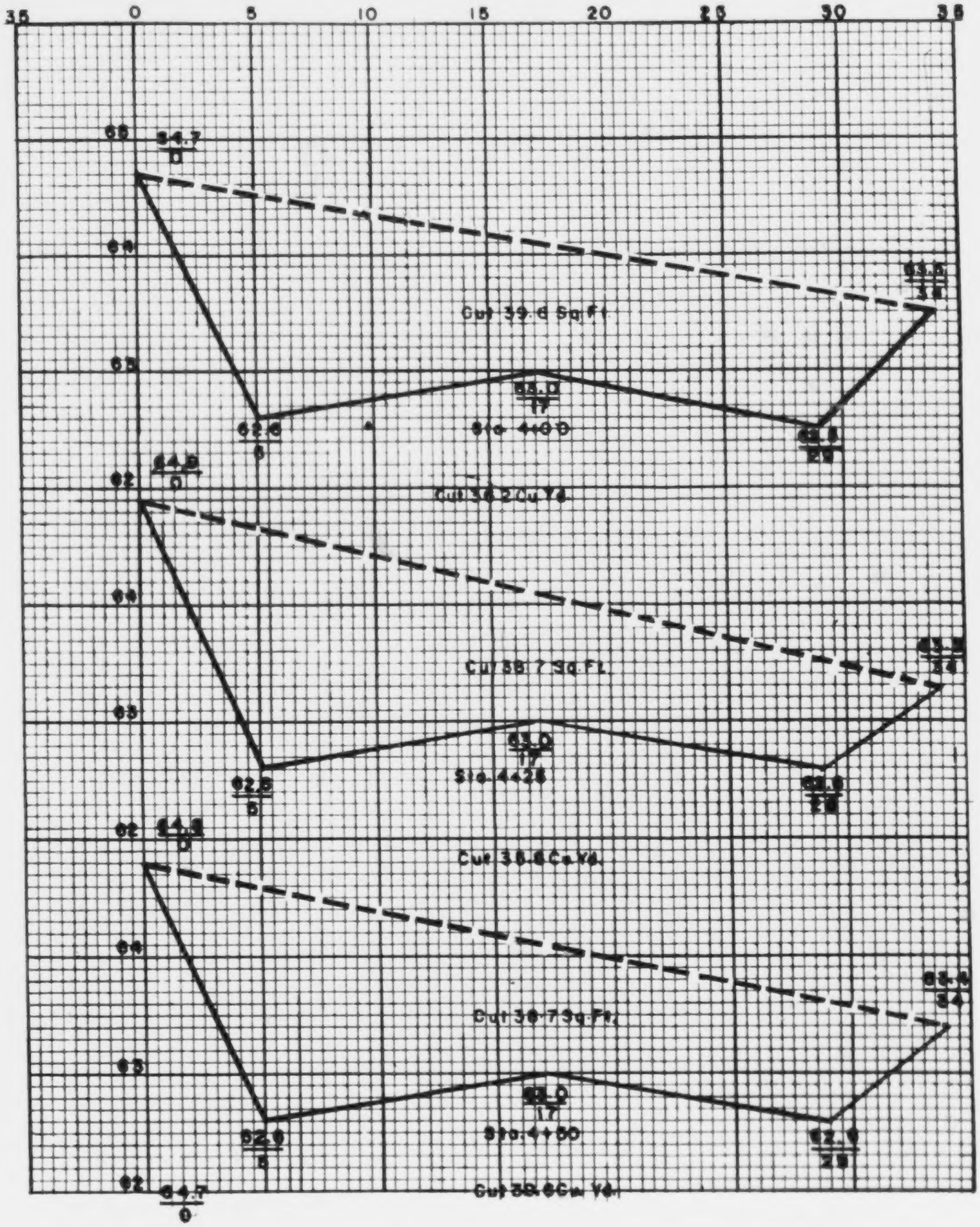
STATION	6=A	7	8	9	10	11	12	13	14=C
Elevation of Tangent	196.80	197.60	198.40	199.20	200.00	199.40	198.80	198.20	197.60
Tangent Offset	0.00	.09	.35	.79	1.40	.79	.35	.09	0.00
Elevation of Curve	196.80	197.51	198.05	198.41	198.60	198.61	198.45	198.11	197.60

Example of a Plan and Profile



From VLSystems, Inc., Irvine, CA.

Example of Cross Sections


35
0
5
10
15
20
25
30
35
65
64
63
62
64
63
62
64
63
62
64.7/0
Cut 39.6 Sq.Ft.
63.0/17
Sta. 4+00
62.6/5
62.8/29
63.5/34
64.8/0
Cut 36.2 Cu.Yd.
Cut 38.7 Sq.Ft.
63.0/17
Sta. 4+25
62.5/5
62.8/29
63.3/34
64.8/0
Cut 38.6 Cu.Yd.
Cut 38.7 Sq.Ft.
63.0/17
Sta. 4+50
62.6/5
62.7/29
63.4/34
64.7/0
Cut 38.6 Cu. Yd.

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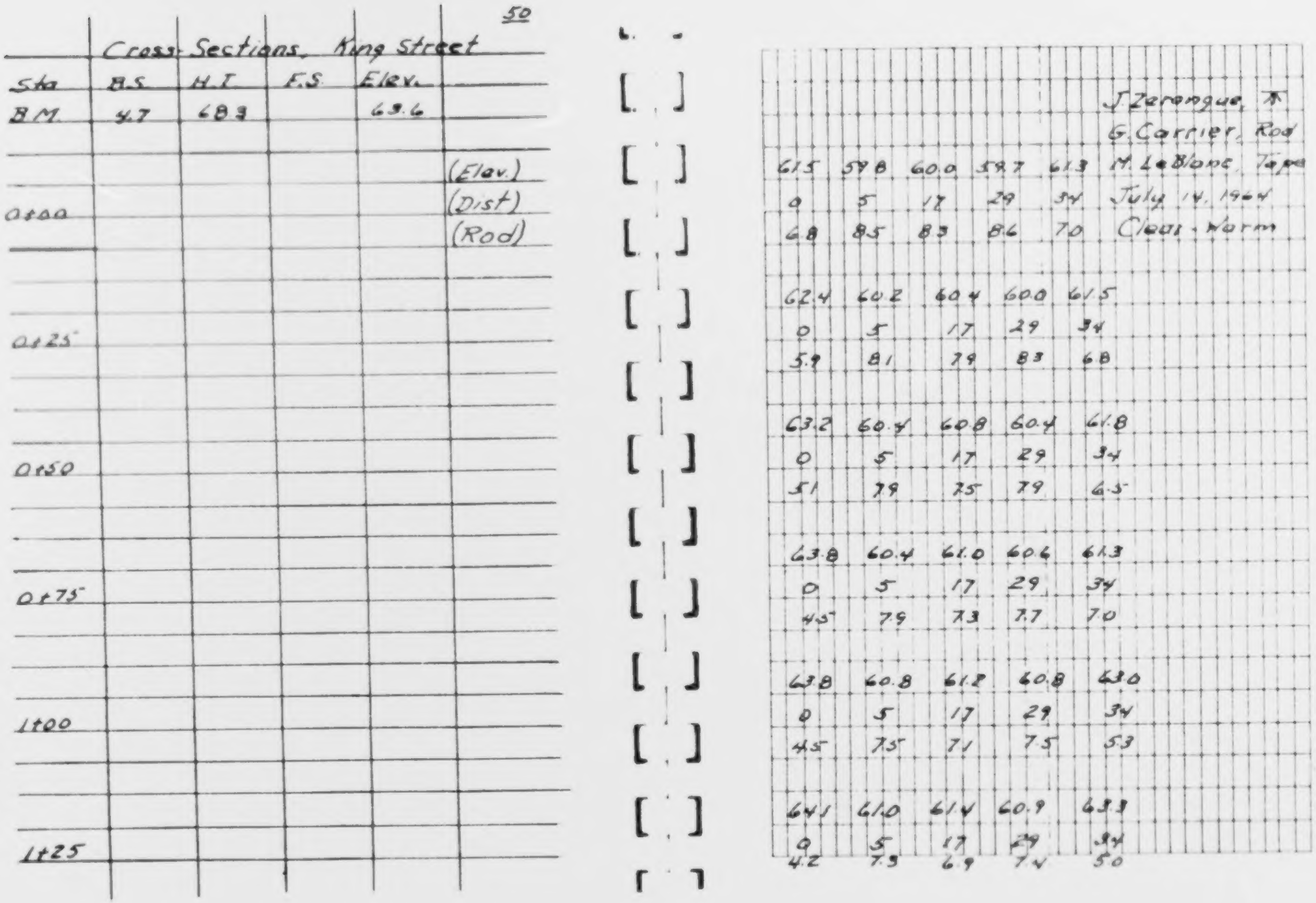
Field Notes for Cross Sections



50

Cross Sections, King Street

Sta	B.S.	H.I.	F.S.	Elev.	
B.M.	4.7	68.3		63.6	
					(Elev.)
0+00					(Dist)
					(Rod)
0+25					
0+50					
0+75					
1+00					
1+25					

					J. Zerangue, ⊼
					G. Carrier, Rod
61.5	59.8	60.0	59.7	61.3	M. LeBlanc, Tape
0	5	17	29	34	July 14, 1964
6.8	8.5	8.3	8.6	7.0	Clear - Warm
62.4	60.2	60.4	60.0	61.5	
0	5	17	29	34	
5.9	8.1	7.9	8.3	6.8	
63.2	60.4	60.8	60.4	61.8	
0	5	17	29	34	
5.1	7.9	7.5	7.9	6.5	
63.8	60.4	61.0	60.6	61.3	
0	5	17	29	34	
4.5	7.9	7.3	7.7	7.0	
63.8	60.8	61.2	60.8	63.0	
0	5	17	29	34	
4.5	7.5	7.1	7.5	5.3	
64.1	61.0	61.4	60.9	63.3	
0	5	17	29	34	
4.2	7.3	6.9	7.4	5.0	

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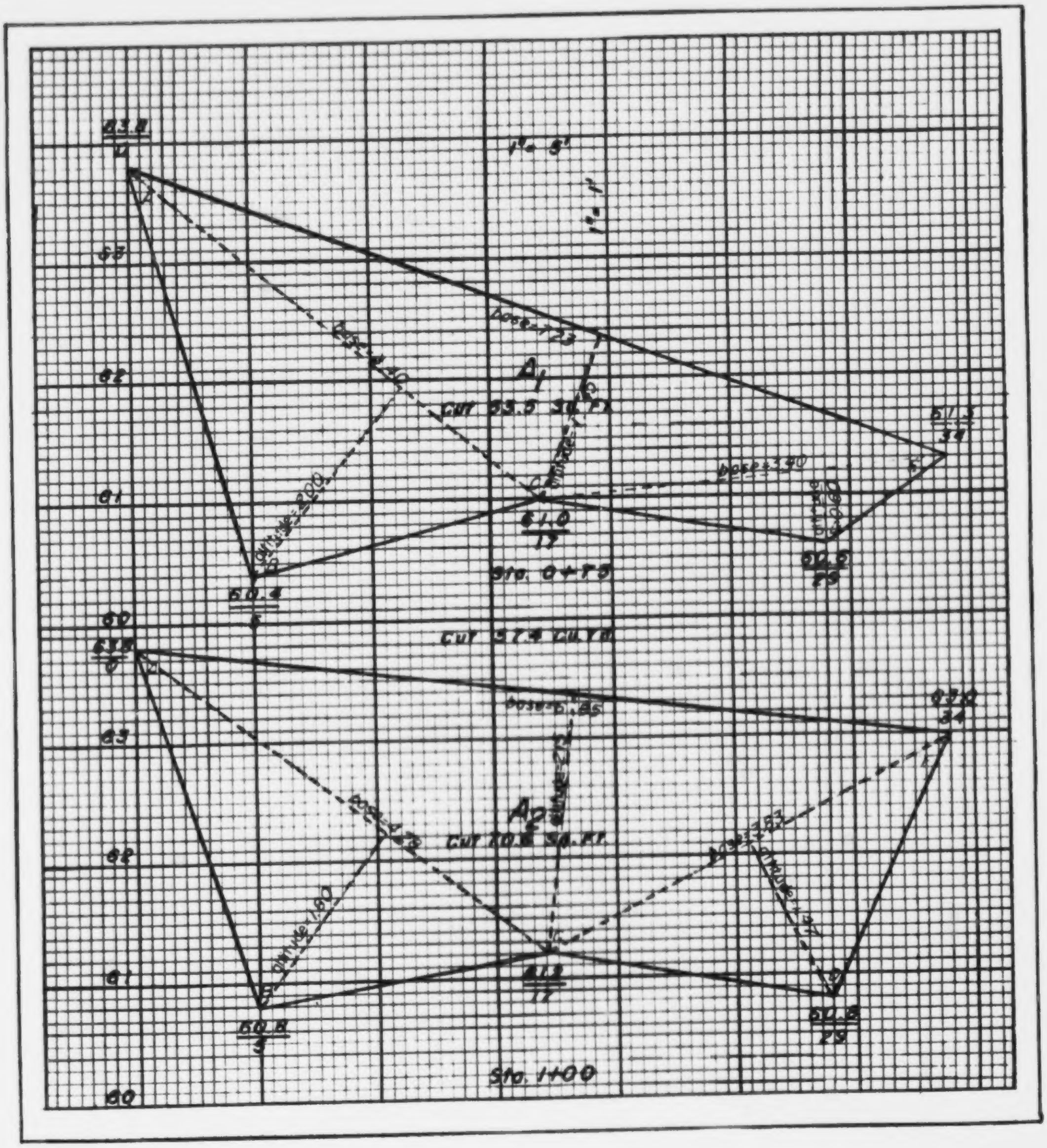
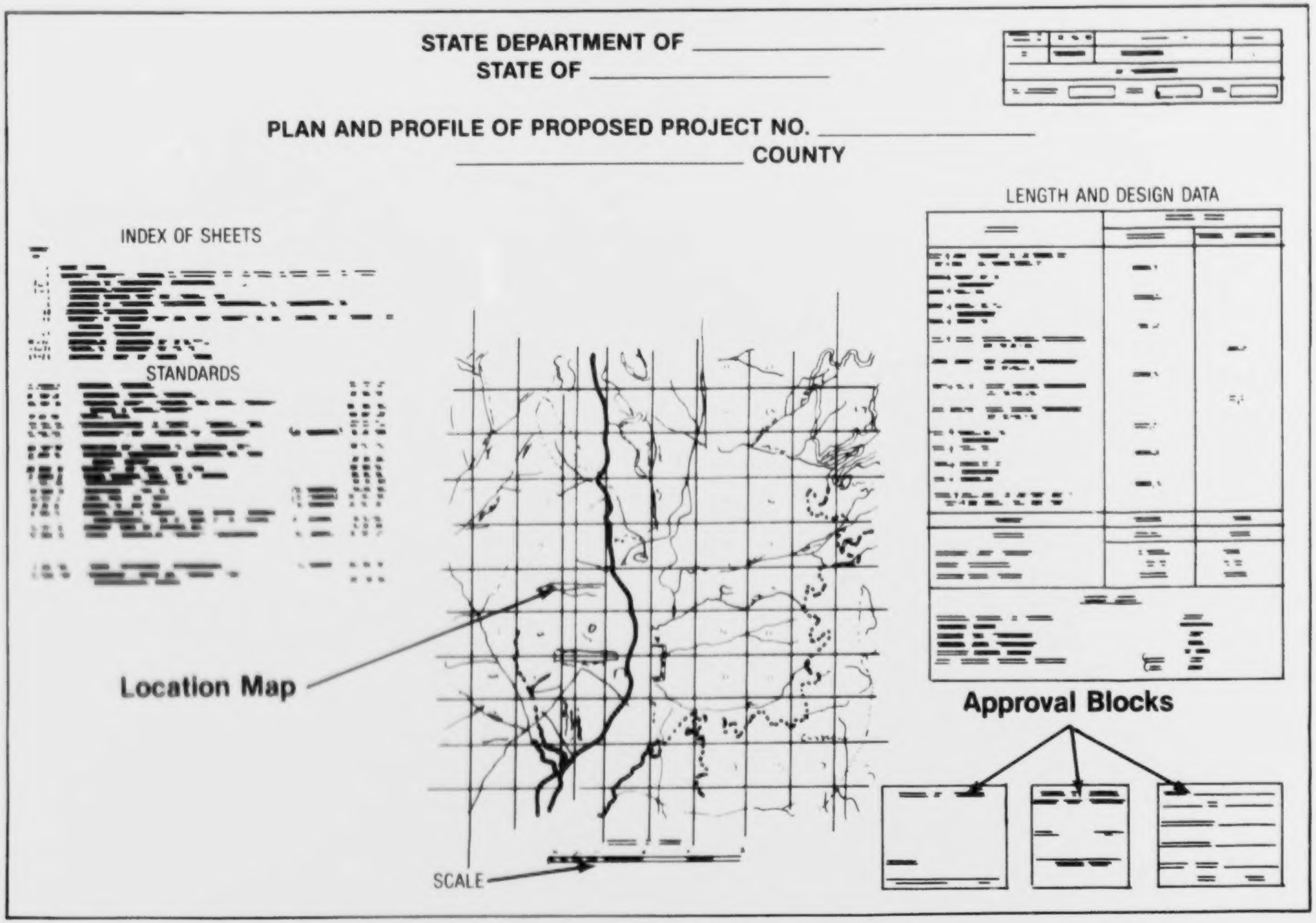
Areas of Cross Sections


63.8
14
1" = 5'
1" = 1'
63
62
61
60
base = 7.23
base = 4.40
A1
CUT 53.5 SQ. FT.
altitude = 2.00
base = 3.90
61.0
17
60.4
5
60.5
29
61.3
34
Sta. 0+75
CUT 57.4 CU. YD.
63.8
0
base = 6.85
A2
CUT 70.8 SQ. FT.
base = 4.23
altitude = 1.80
base = 3.53
61.3
17
60.8
5
60.8
29
63.0
34
Sta. 1+00
60

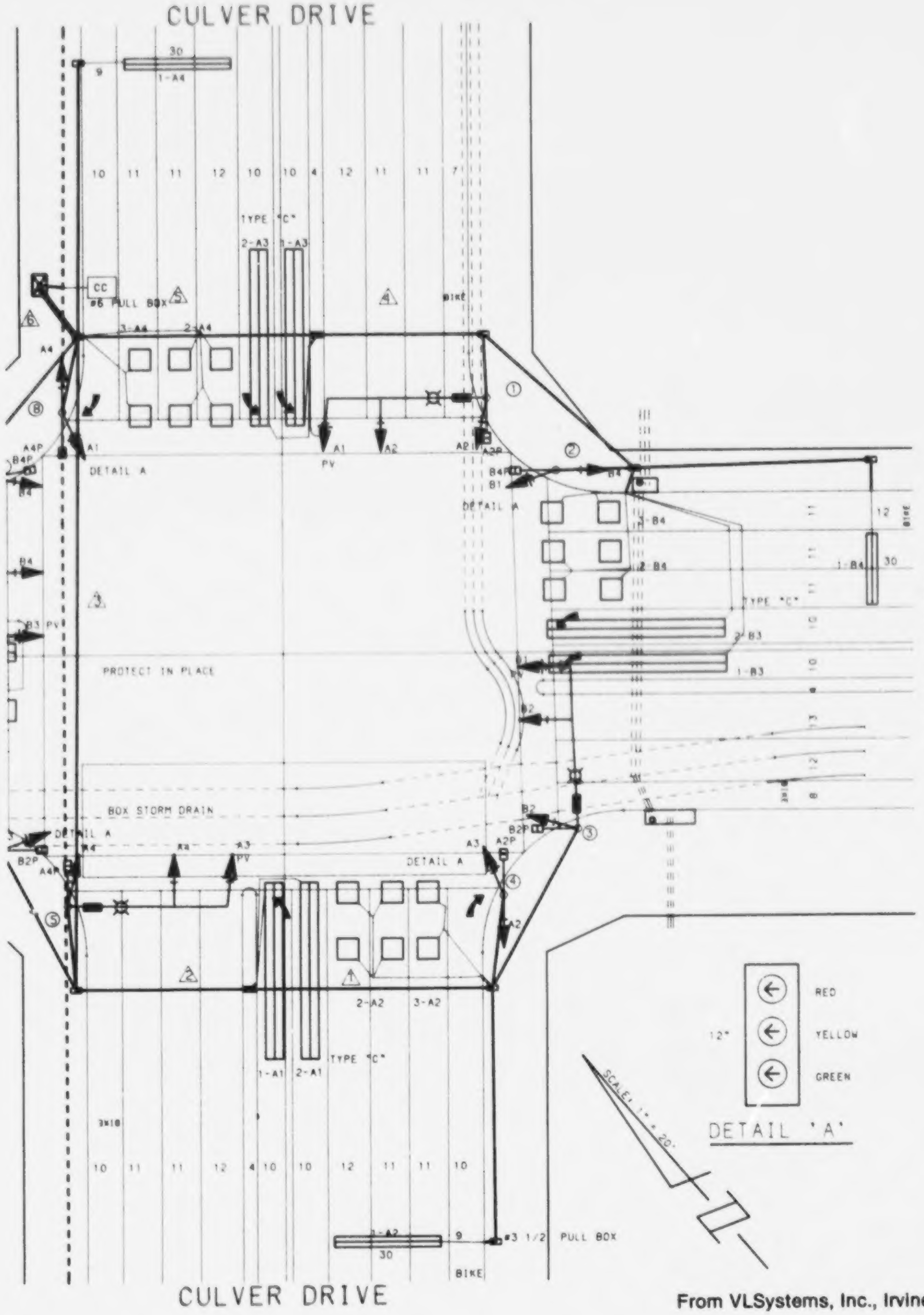
From *Map Drafting and Related Computations for Plane Surveying: Field Book*. Reprinted with permission of the Vocational Curriculum Development and Research Center, Natchitoches, Louisiana.

Typical Title Sheet


STATE DEPARTMENT OF ________
STATE OF ________
PLAN AND PROFILE OF PROPOSED PROJECT NO. ________
________ COUNTY
INDEX OF SHEETS
STANDARDS
LENGTH AND DESIGN DATA
Location Map
Approval Blocks
SCALE

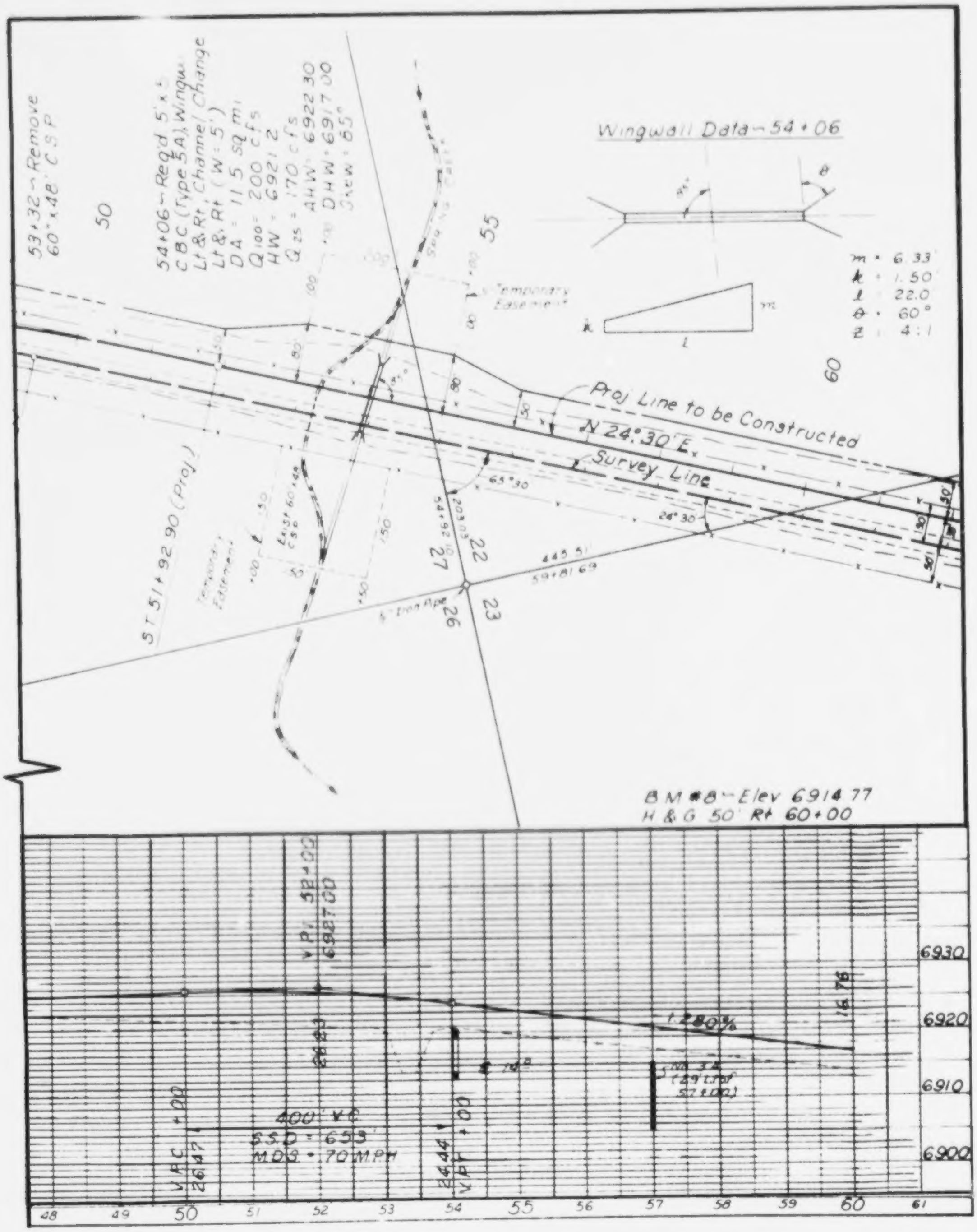
Example of a Highway Detail

Traffic Signal Plan


CULVER DRIVE
30
1-A4
9
10 11 11 12 10 10 4 12 11 11 7
TYPE "C"
2-A3
1-A3
CC
#6 PULL BOX
BIKE
3-A4
2-A4
A4
A4P
B4P
B4
A1
A1
PV
A2
A2
A2P
B4P
B1
DETAIL A
DETAIL A
B4
B3 PV
PROTECT IN PLACE
1-B4
2-B4
12
30
1-B4
TYPE "C"
2-B3
1-B3
B1
B2
B2
B2P
MAIN STREET
BOX STORM DRAIN
DETAIL A
B2P
A4P
A4
A3
A3
PV
A3
A2P
A2
2-A2
3-A2
1-A1
2-A1
TYPE "C"
3x18
10 11 11 12 4 10 10 12 11 11 10
1-A2
30
9
#3 1/2 PULL BOX
BIKE
CULVER DRIVE
RED
YELLOW
GREEN
12"
DETAIL 'A'
SCALE: 1" = 20'

From VLSystems, Inc., Irvine, CA.

Typical Plan and Profile


53+32 ~ Remove
60" x 48" C S P
50
54+06 ~ Req'd 5' x 5'
C B C (Type 5A), Wingw.
Lt & Rt; Channel Change
Lt & Rt (W = 5')
DA = 11.5 sq mi
Q100 = 200 cfs
HW = 6921.2
Q25 = 170 cfs
AHW = 6922.30
DHW = 6917.00
Skew = 65°
55
Wingwall Data ~ 54+06
m = 6.33'
k = 1.50'
l = 22.0
θ = 60°
z = 4:1
60
Temporary Easement
Proj Line to be Constructed
N 24°30' E
Survey Line
65°30'
24°30'
ST 51+92.90 (Proj.)
Temporary Easement
Exist 60"x48" CSP
27
22
26
23
5" Iron Pipe
445.51
59+81.69
BM #8 ~ Elev 6914.77
H & G 50' Rt 60+00
V.P.I. 52+00
6927.00
V.P.C. +00
26.47
V.P.T. +00
24.44
400' V.C.
S.S.D. = 655'
M.D.S. = 70 M.P.H.
1.280%
16.76
6930
6920
6910
6900
48
49
50
51
52
53
54
55
56
57
58
59
60
61

Courtesy of Colorado Department of Highways.

TRANSPORTATION MAPPING
UNIT IX

ASSIGNMENT SHEET #1 — LAYOUT AN OPEN TRAVERSE USING SEVERAL METHODS

PART I: Open Bearing Traverses

1. Start all traverses from the center of a 17 × 22 in. sheet of paper.
2. Plot each traverse to the scale indicated below.
3. Identify each point with a small circle and letter; label each traverse leg with bearing and distance.
4. Label each traverse by number and scale used in a place where it most clearly identifies with the traverse.
5. In the lower left hand corner provide a table with the following headings: Traverse, Closing Distance, Closing Bearing.

   (NOTE: Closure is from the last to the first point.)
6. Provide a border, title block, and north arrow.

Traverse #1: Scale 1" = 200'

Course	Length	Bearing
A-B	364.13	N 32°0' E
B-C	239.20	N 83°30' E
C-D	382.5	N 51°0' W
D-E	241.6	Due North
E-F	310.7	N 16°30' W
F-G	379.1	S 64°0' E
G-H	380.0	N 71°30' E
H-A		

Traverse #2: Scale 1" — 30'

Course	Length	Bearing
A-B	74.0	N 86°30' E
B-C	39.2	N 13°30' E
C-D	54.1	N 67°0' E
D-E	55.8	N 25°30' E
E-F	40.2	S 36°30' E
F-G	52.0	N 43°0' E
G-H	41.9	S 64°0' E
H-A		

Traverse #3: Scale 1" = 50'

Course	Length	Bearing
A-B	81.5	S 27°30' E
B-C	64.5	S 9°0' E
C-D	113.6	S 21°30' E
D-E	134.0	N 14°0' E
E-F	65.1	S 88°30' E
F-G	86.8	N 24°30' E
G-H	174.5	S 70°30' E
H-A		

Traverse #4: Scale 1" = 60'

Course	Length	Bearing
A-B	129.6	S 27°0' W
B-C	120.0	S 16°0' E
C-D	65.3	S 44°30' E
D-E	130.5	S 18°0' W
E-F	153.2	N 19°30' W
F-G	51.7	N 22°30' W
G-H	78.5	N 89°0' W
H-A		

ASSIGNMENT SHEET #1

PART II: Open Azimuth North Traverses

1. Start all traverses from the center of a 17 × 22 in. sheet of paper.
2. Plot each traverse to the scale indicated below.
3. Identify each point with a small circle and letter; label each traverse leg with bearing and distance.
4. Label each traverse by number and scale used in a place where it most clearly identifies with the traverse.
5. In the lower left hand corner provide a table with the following headings: Traverse, Closing Distance, Closing Bearing.

   (NOTE: Closure is from the last to the first point.)
6. Provide a border, title block, and north arrow.

Traverse #1: Scale 1″ = 60′

Course	Length	Azimuth (N)
A-B	108.0	077°0′
B-C	47.5	332°30′
C-D	144.8	108°30′
D-E	176.2	340°30′
E-F	152.0	102°30′
F-G	109.3	339°30′
G-H	99.0	302°30′
H-I	89.2	232°30′
I-J	102.0	0°0′
J-A		

Traverse #2: Scale 1″ = 500′

Course	Length	Azimuth (N)
A-B	465	188°0′
B-C	895	114°30′
C-D	580	148°0′
D-E	565	247°30′
E-F	1200	120°0′
F-G	900	56°30′
G-H	676	358°30′
H-I	808	285°0′
I-J	682	161°30′
J-A		

Traverse #3: Scale 1″ = 30′

Course	Length	Azimuth (N)
A-B	46.6	240°0′
B-C	44.7	267°30′
C-D	42.5	212°0′
D-E	74.8	224°0′
E-F	49.5	279°30′
F-G	37.0	26°0′
G-H	45.7	42°30′
H-I	59.8	279°0′
I-J	21.5	201°0′
J-A		

Traverse #4: Scale 1″ = 2,000′

Course	Length	Azimuth (N)
A-B	2500	288°30′
B-C	3175	32°30′
C-D	2825	18°0′
D-E	2600	302°0′
E-F	5775	234°30′
F-G	4290	351°30′
G-H	2064	226°30′
H-I	4900	276°30′
I-J	4400	57°0′
J-A		

ASSIGNMENT SHEET #1

PART III: Open Deflection Angle Traverses

1. Start all traverses from the center of a 17 × 22 in. sheet of paper.
2. Plot each traverse to the scale indicated below.
3. Identify each point with a small circle and letter; label each traverse leg with bearing and distance.
4. Label each traverse by number and scale used in a place where it most clearly identifies with the traverse.
5. In the lower left hand corner provide a table with the following headings: Traverse, Closing Distance, Closing Bearing.

   (NOTE: Closure is from the last to the first point.)

6. Provide a border, title block, and north arrow.

Traverse #1: Scale 1" = 300'

Course	Length	Defl. Angle
A-B	461	N 61°0' E
B-C	699	54°30' L
C-D	428	99°30' R
D-E	386	41°0' L
E-F	640	105°0' L
F-G	451	62°0' L
G-H	524	43°30' L
H-A	______	______

Traverse #2: Scale 1" = 40'

Course	Length	Defl. Angle
A-B	70.5	S 11°0' E
B-C	34.8	45°30' L
C-D	84.2	37°30' L
D-E	39.3	51°0' L
E-F	51.5	71°0' L
F-G	59.0	72°0' L
G-H	39.0	53°30' R
H-A	______	______

Traverse #3: Scale 1" = 50'

Course	Length	Defl. Angle
A-B	58.0	S 43°0' W
B-C	81.5	23°0' R
C-D	104.5	39°30' L
D-E	85.0	26°30' R
E-F	39.0	18°30' R
F-G	86.0	42°30' R
G-H	166.5	120°0' R
H-I	73.0	113°0' L
I-J	81.7	51°0' L
J-A	______	______

Traverse #4: Scale 1" = 200'

Course	Length	Defl. Angle
A-B	304	N 20°0' W
B-C	401	115°30' L
C-D	163	115°30' R
D-E	301	24°30' L
E-F	442	90°30' L
F-G	758	101°30' R
G-H	387	101°0' R
H-I	339	52°0' R
I-J	741	74°30' L
J-A	______	______

ASSIGNMENT SHEET #1

PART IV: Open Angle Right Traverses

1. Start all traverses from the center of a 17 × 22 in. sheet of paper.
2. Plot each traverse to the scale indicated below.
3. Identify each point with a small circle and letter; label each traverse leg with bearing and distance.
4. Label each traverse by number and scale used in a place where it most clearly identifies with the traverse.
5. In the lower left hand corner provide a table with the following headings: Traverse, Closing Distance, Closing Bearing.

   (NOTE: Closure is from the last to the first point.)

6. Provide a border, title block, and north arrow.

Traverse #1: Scale 1″ = 200′

Course	Length	Angle RT
A-B	245	N 30°0′ W
B-C	474	138°30′
C-D	332	304°0′
D-E	251	102°30′
E-F	392	256°30′
F-G	320	291°0′
G-H	534	76°0′
H-I	229	325°30′
I-J	304	72°0′
J-A	______	______

Traverse #2: Scale 1″ = 60′

Course	Length	Angle RT
A-B	97.5	S 48°0′ E
B-C	95.6	234°30′
C-D	94.0	191°30′
D-E	85.2	36°0′
E-F	131.4	166°0′
F-G	50.1	129°30′
G-H	95.9	151°30′
H-I	133.4	258°30′
I-J	90.2	55°30′
J-A	______	______

Traverse #3: Scale 1″ = 30′

Course	Length	Angle RT
A-B	50.3	S 29°0′ W
B-C	25.0	228°30′
C-D	49.2	119°0′
D-E	72.9	211°30′
E-F	63.4	318°0′
F-G	39.7	76°30′
G-H	50.8	154°0′
H-I	64.2	221°30′
I-J	63.9	323°0′
J-A	______	______

Traverse #4: Scale 1″ = 50′

Course	Length	Angle RT
A-B	87.1	S 86°0′ W
B-C	48.4	153°30′
C-D	88.1	263°30′
D-E	117.8	125°30′
E-F	130.2	238°30′
F-G	80.3	41°30′
G-H	86.4	196°0′
H-I	43.7	82°30′
I-J	34.3	88°30′
J-A	______	______

ASSIGNMENT SHEET #1

PART V: Open Traverses by Coordinates

1. Start all traverses from the center of a 17 × 22 in. paper.
2. Plot each traverse to the scale indicated.
3. Label each point with letters and (X,Y) coordinates.
4. Label each traverse by number and scale used in a place where it most clearly identfies with the traverse.
5. In the right margin provide a table for each traverse with the headings: Course, Length, Bearing.

Traverse #1: Scale 1" = 300'

Point	X-Coord.	Y-Coord.
A	0	0
B	403	224
C	482	918
D	894	800
E	1244	963
F	832	1453
G	391	1360
H	94	928

Traverse #2: Scale 1" = 40'

Point	X-Coord.	Y-Coord.
A	0.0	0.0
B	13.4	−69.2
C	42.8	−88.4
D	126.5	−82.5
E	149.0	−50.4
F	118.7	−8.7
G	62.6	−26.9
H	30.9	−4.3

Traverse #3: Scale 1" = 50'

Point	X-Coord.	Y-Coord.
A	0.0	0.0
B	−39.6	−42.4
C	−114.0	−75.6
D	−160.6	−169.1
E	−228.5	−220.2
F	−265.5	−232.6
G	−344.1	−197.6
H	−209.4	−99.8
I	−348.7	−90.1
J	−271.9	−62.2

Traverse #4: Scale 1" = 200'

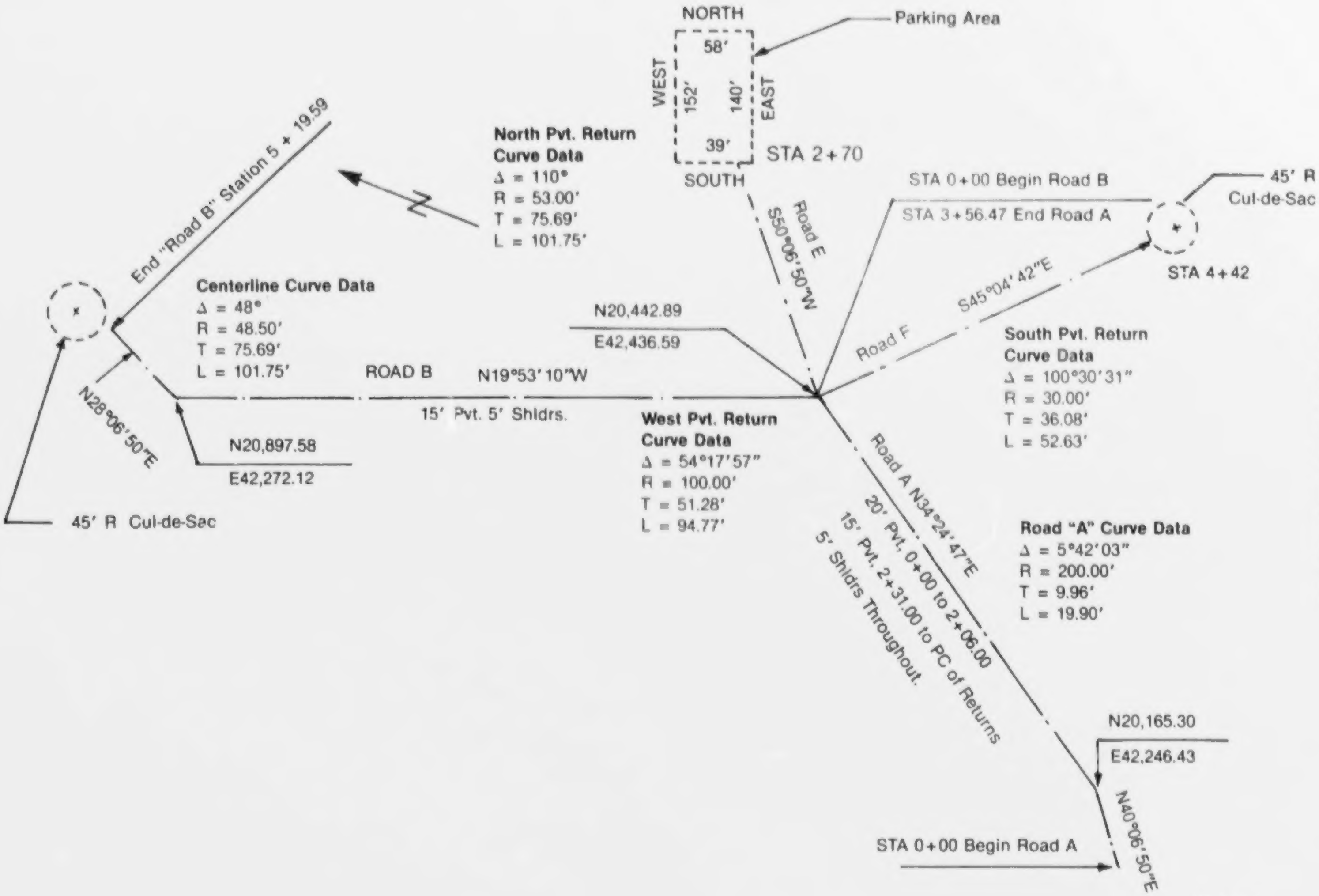
Point	X-Coord.	Y-Coord.
A	0	0
B	−104	286
C	−385	0
D	−441	153
E	−652	368
F	−964	55
G	−1383	687
H	−1025	835
I	−730	668
J	−206	1192

TRANSPORTATION MAPPING
UNIT IX

ASSIGNMENT SHEET #2 — LAYOUT A SURVEY ALIGNMENT FOR A ROAD USING BEARINGS AND COORDINATES

Directions: Using the map developed in Unit IV, Assignment Sheet #6, plot the road data included on the following page. Use the same scale used to layout the other map data. Using the coordinates given on the following sheet, locate the position of the road on the missile site map. Proceed to layout the road centerline by the given bearings and complete the layout of the road by drafting it onto the final map with the road width and shoulders shown.

ASSIGNMENT SHEET #2


NORTH
Parking Area
58'
WEST
152'
140'
EAST
39'
SOUTH
STA 2+70
North Pvt. Return
Curve Data
Δ = 110°
R = 53.00'
T = 75.69'
L = 101.75'
End "Road B" Station 5 + 19.59
Road E
S50°06'50"W
STA 0+00 Begin Road B
STA 3+56.47 End Road A
45' R
Cul-de-Sac
STA 4+42
S45°04'42"E
Road F
Centerline Curve Data
Δ = 48°
R = 48.50'
T = 75.69'
L = 101.75'
N20,442.89
E42,436.59
South Pvt. Return
Curve Data
Δ = 100°30'31"
R = 30.00'
T = 36.08'
L = 52.63'
ROAD B
N19°53'10"W
N28°06'50"E
15' Pvt. 5' Shldrs.
West Pvt. Return
Curve Data
Δ = 54°17'57"
R = 100.00'
T = 51.28'
L = 94.77'
N20,897.58
E42,272.12
45' R Cul-de-Sac
Road A N34°24'47"E
20' Pvt. 0+00 to 2+06.00
15' Pvt. 2+31.00 to PC of Returns
5' Shldrs Throughout.
Road "A" Curve Data
Δ = 5°42'03"
R = 200.00'
T = 9.96'
L = 19.90'
N20,165.30
E42,246.43
N40°06'50"E
STA 0+00 Begin Road A

588

587

TRANSPORTATION MAPPING
UNIT IX

ASSIGNMENT SHEET #3 — PLOT FIELD NOTES FOR HORIZONTAL CONTROL, TOPOGRAPHY, PROFILE, AND CROSS SECTION FOR A PROPOSED ROAD

Given: Field notes for Locust Circle.

1. Horizontal control notes and sketches
2. Profile notes
3. Topographic notes and sketch
4. Cross section notes

Directions: Develop the following maps based on the field notes given.

Map I — Layout the horizontal control survey for the Locust Circle Development. Layout on vellum after determining map size. Use scale 1" = 200'. Ink final map on polyester film with border and standard title block. Discuss appropriate lineweights to use with instructor.

Map II — Plan and profile of Locust Circle

Part I: Plot the centerline of Locust Circle on plan and profile paper. Use horizontal scale of 1" = 100' and vertical scale of 1" = 10'. Layout in pencil. Place plan view in upper half of sheet and set up the profile in gridded portion of sheet.

Part II: Post in the elevation points from the topo field notes for Locust Circle on the plan view. Interpolate the contour line. Indicate contour lines with a dashed line. Label each contour line.

Map III — Cross sections of Locust Circle

Part I: Post the cross section points on the plan view of Locust Circle.

Part II: Using cross section grid paper, plot each cross section for Locust Circle. Horizontal scale is 1" = 5'; vertical scale is 1" = 1'.

ASSIGNMENT SHEET #3

Dave O ⚐ 3-29-79
Tom ⊼ 26°F
Jerry ɸ Calm, Overcast

HORIZONTAL CONTROL SURVEY:
(PT. 20) LOCUST CIRCLE DEVELOPMENT

* HORIZ. TRIANGULATION

BS.	⊼ @	FS.	H.D.	HORIZ.
F	G	E	956.13	70°29′10″
				140°58′10″
				211°27′00″
				70°29′00″
E	G	A		51°16′05″
				102°32′08″
				153°48′09″
				51°16′03″
G	A	E		58°14′25″
				116°28′44″
				174°43′09″
				58°14′23″
E	A	B	1438.98	70°29′12″
				140°58′21″
				211°27′30″
				70°29′10″

Bench Mark

BRASS DISC. USGS #14.B 394a.
HORIZ. & VERT. CONTROL: LOCATION 102.49 DUE SO. & 69.94 DUE WEST OF ℄ CO. #107 & ℄ GATSBY RD.
U.S. DATUM: HORIZ: N: 13,470.29
ELEV: 1299.973 E: 15,891.48

℄ CYRUSSE DR & ℄ 133RD ST.

℄ CYRUSSE DR & LOCUST CIRCLE

℄ HIWAY #46 & 133RD ST.

(NOTE: Figures shown here in bold italics are normally shown in red.)

ASSIGNMENT SHEET #3

(SAME)

A	B	E		35°48′40″	℄ LOCUST CIRCLE & ℄ CYRUSSE DRIVE.
				71°37′20″	
				107°25′57″	
				35°48′39″	
E	B	C	1449.72	73°43′20″	℄ HIWAY #46 & ℄ 130TH ST.
			1449.72	147°26′42″	
			1449.73	221°10′03″	
			1449.72	***73°43′21″***	
B	C	E		52°09′40″	℄ LOCUST CIRCLE & ℄ CYRUSSE DR.
				104°19′21″	
				156°29′03″	
				52°09′41″	
E	C	D		30°21′40″	℄ CO. HIWAY #107 & CYRUSSE DR.
				60°43′19″	
				91°04′57″	
				30°21′39″	
C	D	E	875.56	97°27′30″	℄ LOCUST CIRCLE & ℄ CYRUSSE DR.
				194°55′00″	
				292°22′30″	
				97°27′30″	

ASSIGNMENT SHEET #3

3.

(SAME)

E	D	F		70°29'30"	℄ CO. HIWAY 107 & ℄ GATSBY ROAD
				140°59'05"	
				211°28'42"	
				70°29'34"	
D	F	E		51°11'50"	℄ LOCUST & ℄ CYRUSSE
				102°23'45"	
				153°35'39"	
				51°11'53"	
E	F	G	875.61	58°19'05"	℄ GATSBY ROAD & ℄ LOCUST CIRCLE
			875.61	116°38'14"	
			875.60	174°57'21"	
				58°19'07"	
A	E	G		70°29'32"	" " " " " "
				140°59'06"	
				211°28'42"	
				70°29'34"	
G	E	F		51°11'48"	℄ CO. HIWAY 107 & ℄ GATSBY RD.
				102°23'45"	
				153°35'39"	
				51°11'53"	

ASSIGNMENT SHEET #3

4.

F	E	D		58°18'30"
				141°37'05"
				174°55'39"
				58°78'33"
D	E	C		52°10'50"
				104°21'41"
				156°32'33"
				52°10'51"
C	E	B		54°07'00"
				108°13'58"
				162°20'54"
				54°06'58"
B	E	A		73°42'10"
				147°24'21"
				221°06'33"
				73°42'11"

(END HORIZ. CONTROL)

(SAME)

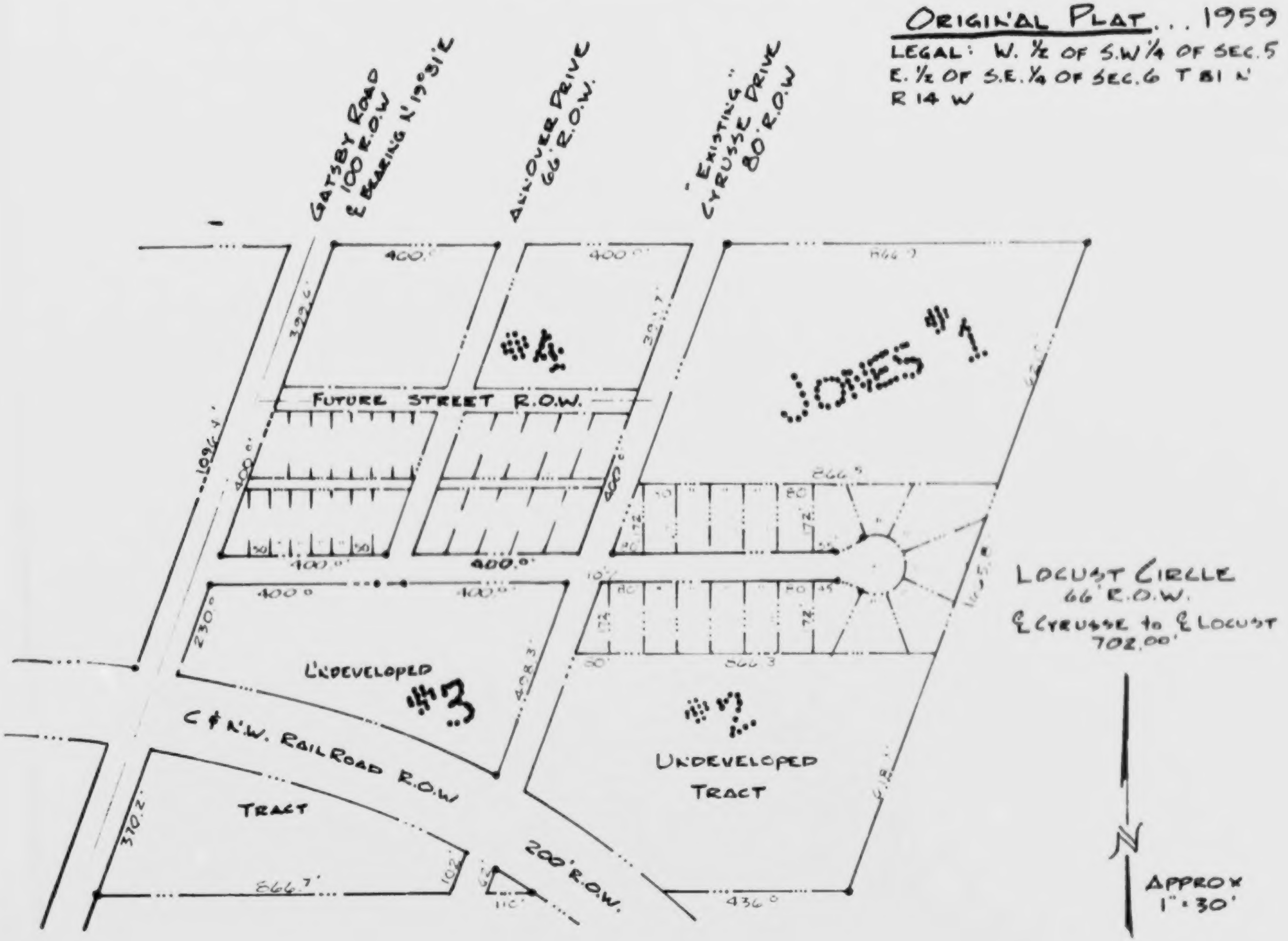
℄ CO. HIWAY 107 & ℄ CYRUSSE DR.

℄ #46 & 130TH ST.

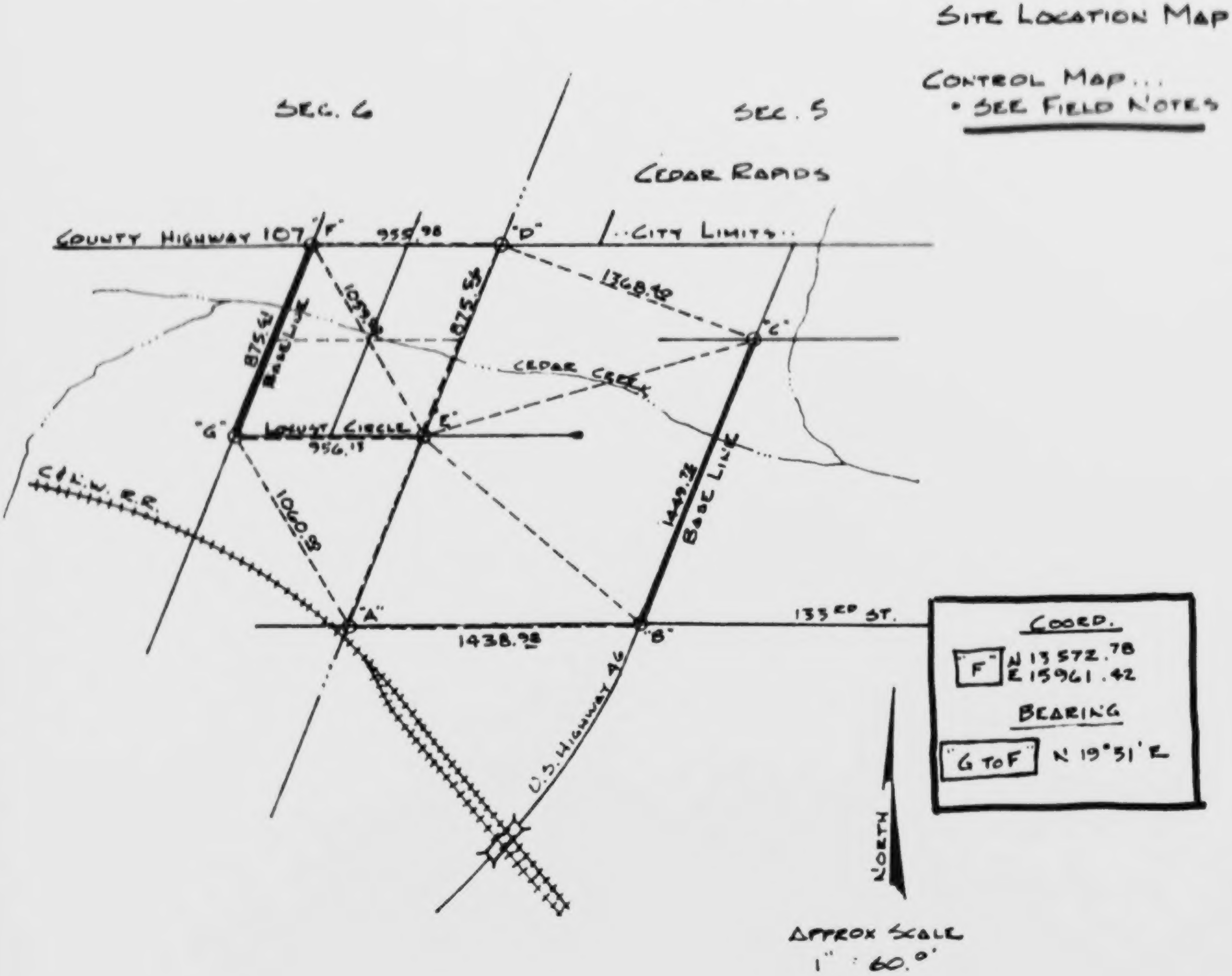
℄ #46 & 133RD ST.

℄ CYRUSSE & 133RD

ASSIGNMENT SHEET #3


ORIGINAL PLAT . . . 1959
LEGAL: W. ½ OF S.W ¼ OF SEC. 5
E. ½ OF S.E. ¼ OF SEC. 6 T 81 N
R 14 W
GATSBY ROAD
100 R.O.W
℄ BEARING N 19°31' E
ALLOVER DRIVE
66' R.O.W.
"EXISTING"
CYRUSSE DRIVE
80 R.O.W
400.0'
400.0'
866.7
392.6'
1094.4'
FUTURE STREET R.O.W.
JONES #1
#4
400.0'
400.0'
400.0'
400.0'
866.5
866.3
80
72
LOCUST CIRCLE
66' R.O.W.
℄ CYRUSSE to ℄ LOCUST
702.00'
230.0
408.3'
UNDEVELOPED
#3
#2
UNDEVELOPED
TRACT
C & N.W. RAILROAD R.O.W
200' R.O.W.
TRACT
370.2'
866.7'
436.0
N
APPROX
1" = 30'

ASSIGNMENT SHEET #3


SITE LOCATION MAP
CONTROL MAP...
• SEE FIELD NOTES
SEC. 6
SEC. 5
CEDAR RAPIDS
COUNTY HIGHWAY 107
"F"
955.98
"D"
CITY LIMITS
1368.40
1033
875.54
875.61
BASE LINE
"C"
CEDAR CREEK
"G"
LOCUST CIRCLE
"E"
956.13
C&N.W. R.R.
1060.18
1449.73
BASE LINE
"A"
1438.98
"B"
133RD ST.
U.S. HIGHWAY 46
COORD.
"F" N 13572.78
E 15961.42
BEARING
"G TO F" N 19°51' E
NORTH
APPROX SCALE
1" : 60.0'

ASSIGNMENT SHEET #3

PROFILE NOTES:

℄ LOCUST CIRCLE

3-31-79
D. OLSON
T. CROYMANS

ASSIGNMENT SHEET #3

D. Olson ⊼ 🕮 3-31-79
Tom C. ϕ 41°F Calm

TEMP. BENCH CIRCUIT

BM$_1$	8.72	***1308.69***			1299.973	DESCRIPTION SEE PG. #1
TP$_1$	4.49	***1306.49***	6.69	***1302.003***		SPIKE IN P.P. 290′ SO.
TP$_2$	4.98	***1306.33***	5.14	***1301.35***		T/ROCK NEAR APPROACH
TP$_3$	5.09	***1306.40***	5.02	***1301.31***		℄ DRIVE (NAIL)
TBM$_1$	8.21	***1306.76***	7.85	***1298.553***		SPIKE IN P. POLE WEST SIDE OF GATSBY ON ℄ OF LOCUST CIRCLE.
TP$_4$	4.87	***1306.173***	5.46	***1301.30***		SAME AS TP$_3$
TP$_5$	5.16	***1306.51***	4.82	***1301.353***		T/PIN
TP$_6$	5.87	***1305.85***	6.53	***1299.983***		T/PIN
BM$_1$			5.90	***1299.953***	1299.973	SEE PG. #1
					.02 LOW	
	PROFILE ON "PG. 7"					

(NOTE: Figures shown here in bold italics are normally shown in red.)

ASSIGNMENT SHEET #3

PROFILE OF "LOCUST" SAME

TBM.	2.96	***1301.513***			***1298.553***	DESCRIPTION ON PG. 6 (TMB.)
0-25			0.80	***1300.71***		SHOT ON EXIST. GRD. @ ℄ LOCUST
0+00			0.17	***01.34***		"
0+25			0.92	***00.59***		"
+50			1.47	***00.04***		"
+75			1.70	***1299.81***		"
1+00			2.11	***99.40***		"
+25			2.34	***99.17***		"
+50			2.61	***98.90***		"
+75			2.93	***98.58***		"
2+00			3.20	***98.31***		"
+25			3.07	***98.44***		"

ASSIGNMENT SHEET #3

		1301.513				SAME
2+50			2.99	**1298.52**		GRD. SHOTS...
+75			2.95	**98.56**		"
3+00			2.91	**98.60**		"
+25			3.03	**98.48**		"
+50			3.26	**98.25**		"
+75			3.58	**97.81**		"
4+00			3.70	**97.81**		"
+25			3.83	**97.68**		"
TBM,	1.58	**1299.023**	4.07	**1297.443**		CONC. MONMT NE ANNOVER & LOCUST
+50			3.52	**95.50**		GRD SHOTS
+75			2.81	**96.21**		"
5+00			2.20	**96.82**		"

ASSIGNMENT SHEET #3

		1299.023				SAME	
5+25			2.04	***96.98***		GRD. SHOTS @	LOCUST
+50			2.52	***96.50***		"	
+75			2.81	***96.21***		"	
6+00			2.94	***96.08***		"	
+25			2.99	***96.03***		"	
+50			2.91	***96.11***		"	
+75			3.04	***95.98***		"	
7+00			3.07	***95.95***		"	
+25			3.10	***95.92***		"	
+50			3.22	***95.80***		"	
+75			3.59	***95.43***		"	
8+00			3.70	***95.32***		"	

ASSIGNMENT SHEET #3

		1299.023				SAME
8+25			3.99	***95.03***		GRD. SHOTS
+50			4.11	***94.91***		"
+75			4.83	***94.19***		"
9+00			5.21	***93.81***		"
+25			5.63	***93.39***		"
+50			6.04	***92.98***		"
9+56 (T.P.)			5.91	***1293.11***		T/SAN SWR. M.H.
TBM$_3$	0.03	***1293.143***	5.91	***1293.11***		N. RIM S.M.H. ℄ ℄ CYRUSSE & LOCUST (STA. 9+56)
9+75			0.42	***92.72***		GRD SHOTS
10+00			0.39	***92.75***		"
+25			0.42	***92.72***		"
+50			0.45	***92.69***		"
+75			0.51	***92.63***		"

ASSIGNMENT SHEET #3

11.

		1293.143				SAME
11+00			0.63	**1292.513**		GRD. SHOTS
+25			0.73	**92.41**		"
+50			0.90	**92.243**		"
+75			1.02	**92.12**		"
12+00			1.12	**92.02**		"
+25			1.37	**91.77**		"
+50			1.68	**91.46**		"
+75			2.14	**91.003**		"
13+00			2.53	**90.61**		"
+25			2.61	**90.53**		"
+50			2.77	**90.37**		"
+75			2.89	**90.25**		"

ASSIGNMENT SHEET #3

		1293.143			
14+00			3.13	**90.01**	
+25			3.20	**89.94**	
+50			3.51	**89.63**	
+75			3.82	**89.32**	
15+00			4.29	**88.85**	
TBM,	1.40	**1289.903**	4.64	**1288.503**	
15+25			1.26	**88.64**	
+50			1.38	**88.52**	
+75			1.41	**88.49**	
16+00			2.45	**87.45**	
+25			2.55	**87.35**	
+50			2.79	**87.11**	

SAME

PAINTED SPIKE IN P.P. 48' SO. ℄

ASSIGNMENT SHEET #3

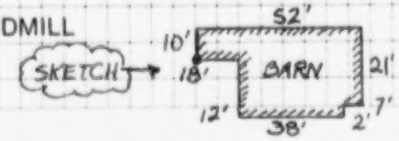
		1289.903				SAME
16+58			2.89	***87.01***		℄ ℄ LOCUST CIRCLE CUL-DE-SAC
16+75			2.91	***86.99***		
17+00			3.02	***86.88***		
TP$_4$	5.61	***95.103***	0.41	***1289.493***		
TP$_5$	4.04	***97.733***	1.41	***93.693***		
TBM$_2$	1.71	***99.163***	0.28	***97.453***	1297.443	DESCRIPTION ON PG. #8
TP$_7$	4.54	***1302.773***	0.93	***98.233***		
TP$_8$	5.02	***1303.633***	4.16	***98.613***		
BM$_1$			3.69	***1299.943***	1299.973	DESCRIPTION ON PG. #1
					.03 LOW	
END PROFILE OF "LOCUST"						

(NOTE: Figures shown here in bold italics are normally shown in red.)

ASSIGNMENT SHEET #3

D. OLSON 4-2-79 20.
T. CROYMANS 61°

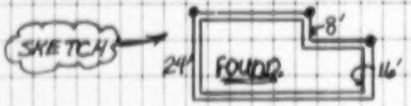
TOPO OF: LOCUST CIRCLE

STA.	OFFSET (LT)	OFFSET (RT)	DESCRIPTION...
0-50	ON LINE		BARB FENCE RUNS DIAG. W/PROP.
0-48	ON LINE		POWER POLE ON ℄ LOCUST.
0-04	84.4′		℄ 24" DIA. R.C.P. STORM SEWER CULVERT
0+02		28.5′	℄ STORM SEWER M.H. (4.9′ DEEP)
0+20		75.0	BARB FENCE ANGLES W/PROPERTY
0+57	68.4′		EAST END 24" R.C.P. ST'M SW'R CULVERT
0+60	35.0′		FENCE CORNER. (BARBED)
0+60		53.0	18" DEC. TREE
0+71	34.0		PWR POLE (NE TO SW)
0+77	34.0		PWR POLE (EW TO SW)
0+83		21.3	12" DEC. TREE
0+92	88.5		10" " TREE
1+10		42.0	6" " TREE
1+18		42.5	6" " TREE
1+30		42.0	6" " TREE
1+61		33.0	FENCE CORNER (LOT DIVISION) DIAG. SW (CHAIN LINK)
*0+41		33.5	FENCE CORNER (DIAG.) BARBED
1+65	33.5		FENCE CORNER (DUE NORTH) BARBED
1+83		45′	℄ 55′ DIA. WTR STOR TANK (MEA. TO FACE)
1+88		18′	6" DEC. TREE
1+95	108.0′		18" DEC. TREE
2+02	57.5′		OLD ABAN. WINDMILL
2+37	88.3′		N.W. BARN 

ASSIGNMENT SHEET #3

SAME

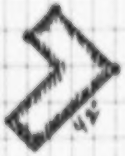
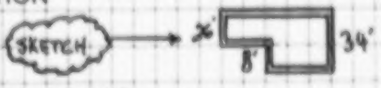
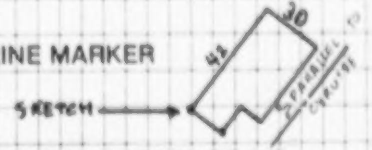
2+38	33.0			SHOT ON FENCE LINE (E-W)
2+50	70.0			SHOT @ SW BARN
2+51	32.8			FENCE CORN. BEND 90° TO NORTH.
2+70		40.0		℄ 70' DIA. WT'R STOR. TANK (MEA. TO FACE)
2+88	70.4			BARN JOGS NORTH 7.0' & 2.0' EAST
3+12		33.4		NE CORN. FENCE GOES DUE SO. (CHAIN LINK)
3+14	58.0			8" PINE TREE
3+25	57.0			" " "
3+36	57.0			" " "
3+46	56.0			" " "
3+58	56.0			" " "
•3+25		38.0'		NW OLD CONC. FOUNDATION
3+53		38.5'		NE " "
3+69		46.5'		NE " "
3+81	18.0'			6" DEC. TREE
3+92	41.0			8" " TREE
4+20	28.0			FENCE BARBED DUE NO. BEGIN EAST
4+31		15.0		℄ 14' OLD GRAVEL DRIVE TO WATER SITE
4+42	48.0			℄ 24" DIA. DEC. TREE
4+49.8	27.5			FENCE (BARBED) TO WEST ANGLES NE
4+52		41.0		℄ ABANDON CONC. WELL (UNDERGROUND)
4+55		65.0		℄ GRAVEL DRIVE TO OLD BARN (10' WIDE)
4+73	27.0			NW END OF 15" C.M.P. CULVERT @ SKEW
4+88		21.0		SE END OF " " " " "



ASSIGNMENT SHEET #3

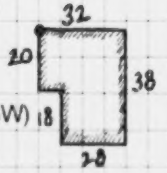
5+01		44'
5+15		20'
5+57		44.5'
*5+29	31	
5+58	53	
5+71		27
5+80	48.0'	
5+94	48.5	
6+16	40.5	
6+20		20.8'
6+35		47.5
*6+83	33.8	
7+05		34.0'
7+30		52.0'
7+66		53.0'
8+18		44.0'
8+50		72.0'
8+66	58'	
8+94	50'	
*8+67		91.0'
8+89		42.0'
9+08		
9+28	30'	
*9+14	43'	

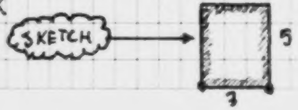
SAME

NW	BARN SET @ SKEW 
NW	" " " "
NE	" " " "
FENCE	(BARBED) GOES EAST ANGLES NE
15" DEC. TREE	
18" " TREE	
SW	OLD FOUNDATION
SW INSIDE	" " 
SE	FOUNDA.
BURIED NAT. GAS LINE MARKER	
PW'R POLE LINES (SW-NE)	
PW'R POLE (LINES E-W & TO SW)	
FENCE	BARBED TO EAST & DUE SO.
12" DEC. TREE	
15" " TREE	
10" PINE	
BURIED GAS LINE MARKER	
SW	HOUSE 
SE	HOUSE
BEGIN ROW OF 7 PINES (SKEW TO NE)	
END ROW OF PINES (EQUALLY SPACED)	
FENCE	(BARBED) TO WEST & SW
BURIED GAS LINE MARKER	
8" DEC. TREE	

ASSIGNMENT SHEET #3

			SAME
9+47	48.0′		℄ GRAVEL DRIVE WAY
9+49	132′		6″ PINE
9+52	153′		6″ PINE
9+60.5		0.8′	℄ SAN. SW'R M.H. (8.45′ DEEP)
9+83		36.0′	R.E.A. LITE POLE
9+94		53	NW HOUSE
10+07	34.0		P. POLE (LINES: W – + NE TO SW)
10+15	34′		FIRE HYDRANT
10+19		35.0′	BEGIN ROW OF BUSHES
10+26		53.0	NE HOUSE
10+75		35.0′	END ROW OF BUSHES
11+48	41.0		20″ DEC. TREE
11+52		38.0′	BEGIN ROW OF 7 PINES (DUE SOUTH) (35 LONG)
12+30	46.0′		24″ DEC. TREE
12+45		20.0	18″ DEC. TREE
12+63		13.0	20″ ″ ″
13+02	28		6″ DEC. TREE
13+09	36		8″ ″ TREE
13+25	35′		FENCE BARBED TO NE
13+73	108		″ ″ ″ TO SE & DUE EAST
13+77		46′	26″ DEC. TREE
14+02		35′	BEGIN FENCE (ROCK) DUE SOUTH
14+38		44′	SW SHACK
14+41		46′	SE SHACK





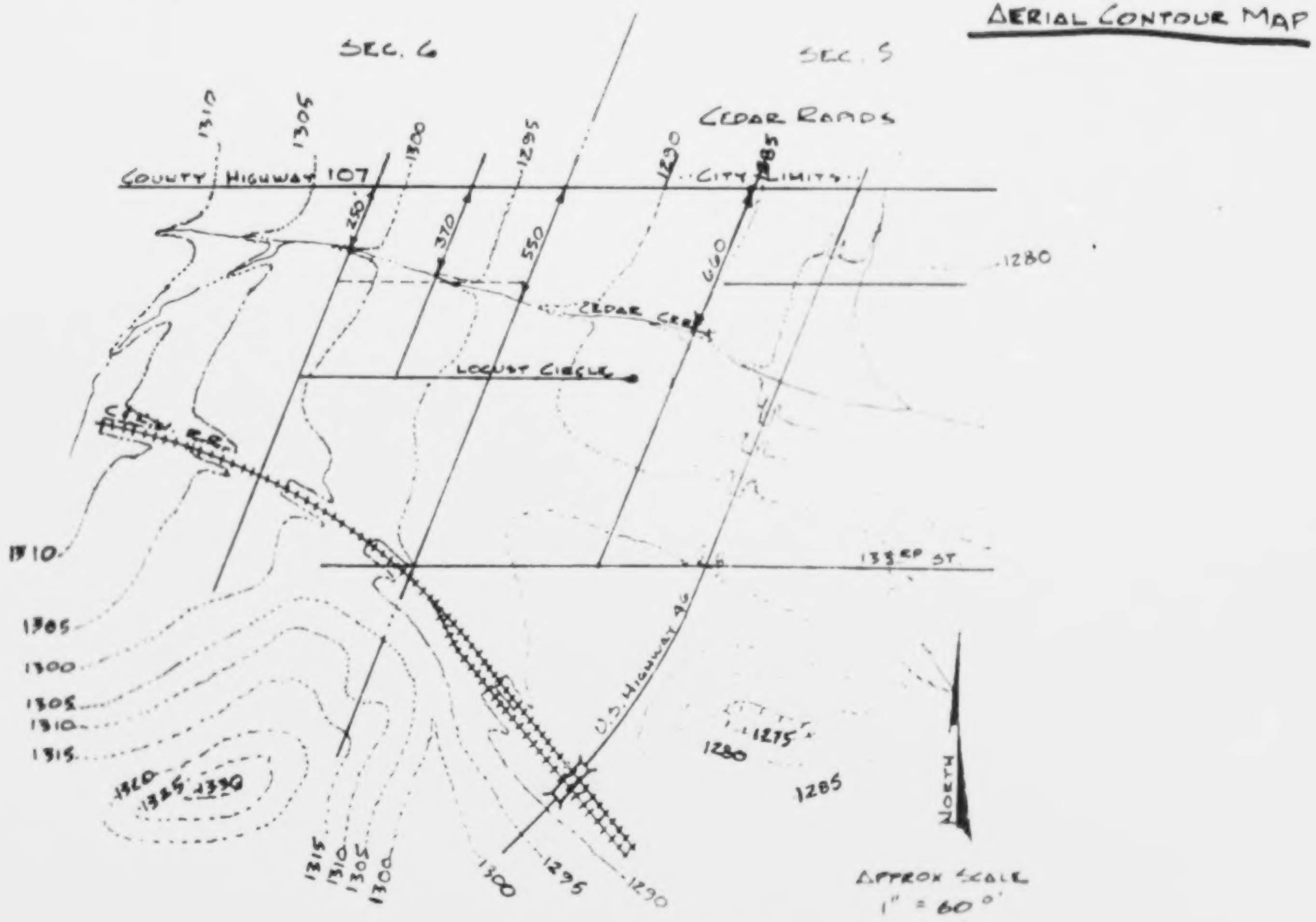
ASSIGNMENT SHEET #3

			SAME
14+82	36.0'		BEGIN BARB. FENCE TO NORTH
15+27		48'	PWR. POLE LINES DUE N & S
16+58			APPROX. ℄ ℄ FUTURE LOCUST.
16+71		28'	14" DEC. TREE
16+73	72'		6" PINE TREE
17+41	12'		6" DEC. TREE
17+64	21'		10" " TREE
18+18	1.5'		20" DEC. TREE

END OF TOPO

BEER 30

ASSIGNMENT SHEET #3


Aerial Contour Map
Sec. 6
Sec. 5
Cedar Rapids
County Highway 107
City Limits
1310
1305
1300
1295
1290
1285
250
370
550
660
1280
Cedar Cir.
Locust Circle
C.&N.W. R.R.
133rd St.
U.S. Highway 96
1310
1305
1300
1305
1310
1315
1320
1325
1330
1315
1310
1305
1300
1300
1295
1290
1275
1280
1285
North
Approx Scale
1" = 60'

ASSIGNMENT SHEET #3

X-SECTIONS: LOCUST CIRCLE

TBM.	4.96				1298.553
0+00		DOWN ℄ GATSBY RD...			
0+50					
1+00					
1+50					
2+00					

D. OLSON 🕮 ⊼ 4-4-79
T. CROYMAN ϕ COOL, MISTY

SEE PG. 6 FOR DESCRIPTION

	LT.	←	℄	→	RT.	
2.35 50′	2.31 25′	2.24 15′	2.21 0′	2.10 15′	2.03 25′	1.97 50′
3.15 50′	3.80 25	4.40 15	3.47 0	4.16 15′	3.72 25′	2.95 50′
3.67 50′	3.85 25′	4.02 15	4.11 0	4.40 15	5.20 25	4.80 50
3.25 50	3.71 25′	4.10 15′	4.61 0	4.90 15	5.31 25	4.99 50
5.30 50′	5.12 25′	5.02 15	5.23 0	5.45 15	5.60 25	4.90 50

ASSIGNMENT SHEET #3

2+50					
3+00					
3+50					
4+00					
4+50					

SAME

$\frac{4.30}{50'}$	$\frac{4.50}{25'}$	$\frac{4.80}{15'}$	$\frac{4.98}{0}$	$\frac{5.05}{15'}$	$\frac{5.20}{25'}$	$\frac{5.50}{50'}$
$\frac{4.90}{50}$	$\frac{5.45}{25}$	$\frac{5.10}{15}$	$\frac{4.93}{0}$	$\frac{5.00}{15}$	$\frac{5.10}{25}$	$\frac{5.30}{50}$
$\frac{4.70}{50}$	$\frac{4.84}{25}$	$\frac{5.00}{15}$	$\frac{5.26}{0}$	$\frac{5.30}{15}$	$\frac{5.51}{25}$	$\frac{5.62}{50}$
$\frac{5.10}{50}$	$\frac{5.42}{25}$	$\frac{5.70}{15}$	$\frac{5.71}{0}$	$\frac{5.90}{15}$	$\frac{6.20}{25}$	$\frac{5.75}{50}$
$\frac{5.40}{50}$	$\frac{5.85}{25}$	$\frac{6.20}{15}$	$\frac{8.01}{0}$	$\frac{8.15}{15}$	$\frac{6.50}{25}$	$\frac{6.31}{50}$

ASSIGNMENT SHEET #3

5+00					
5+50					
T.P.₁	4.04		7.61		
6+00					
6+50					
7+00					

SAME

$\frac{6.00}{50'}$	$\frac{5.40}{25'}$	$\frac{5.82}{15'}$	$\frac{6.70}{0}$	$\frac{6.50}{15'}$	$\frac{6.20}{25'}$	$\frac{5.80}{50'}$
$\frac{6.30}{50}$	$\frac{6.10}{25}$	$\frac{6.85}{15}$	$\frac{7.00}{0}$	$\frac{7.35}{15}$	$\frac{7.50}{25}$	$\frac{8.02}{50}$

T/CONC. FOUNDATION

$\frac{2.65}{50}$	$\frac{3.10}{25}$	$\frac{3.50}{15}$	$\frac{3.82}{0}$	$\frac{4.14}{15}$	$\frac{4.90}{25}$	$\frac{4.02}{50}$
$\frac{2.85}{50}$	$\frac{3.00}{25}$	$\frac{3.41}{15}$	$\frac{3.68}{0}$	$\frac{4.00}{15}$	$\frac{4.75}{25}$	$\frac{3.81}{50}$
$\frac{2.56}{50}$	$\frac{2.95}{25}$	$\frac{3.70}{15}$	$\frac{4.04}{0}$	$\frac{4.31}{15}$	$\frac{5.10}{25}$	$\frac{4.30}{50}$

ASSIGNMENT SHEET #3

7+50					
8+00					
8+50					
9+00					
9+50					

SAME

3.32	3.61	3.85	4.14	3.60	3.50	3.10
50	25	15	0	15	25	50
3.75	3.95	4.15	4.63	3.92	3.85	3.42
50	25	15	0	15	25	50
4.12	4.32	4.63	5.02	4.40	4.25	3.91
50	25	15	0	15	25	50
5.10	5.25	5.75	6.12	5.21	5.05	4.81
50	25	15	0	15	25	50
6.21	6.67	6.62	6.94	6.52	6.31	6.00
50	25	15	0	15	25	50

ASSIGNMENT SHEET #3

10+00					
T.P.$_2$	3.26		8.18		
10+50					
11+00					
11+50					
12+00					

SAME

5.80	6.02	6.85	7.14	6.61	6.47	6.20
50	25	15	0	15	25	50

T/FENCE POST.

1.75	1.84	2.12	2.34	2.00	2.10	1.94
50	25	15	0	15	25	50
1.95	2.04	2.20	2.54	2.30	2.00	2.10
50	25	15	0	15	25	50
2.95	2.90	2.81	2.83	2.70	2.81	2.85
50	25	15	0	15	25	50
3.49	3.31	3.15	3.05	3.10	3.30	3.21
50	25	15	0	15	25	50

ASSIGNMENT SHEET #3

12+50					
13+00					
13+50					
14+00					
14+50					
15+00					

SAME

3.32 50	3.19 25	3.07 15	2.83 0	3.15 15	3.24 25	3.51 50
4.70 50	4.67 25	4.42 15	4.44 0	4.61 15	4.81 25	4.52 50
5.25 50	4.91 25	4.75 15	4.63 0	4.87 15	5.07 25	5.18 50
5.66 50	5.45 25	5.07 15	5.00 0	5.55 15	5.77 25	5.80 50
5.92 50	5.67 25	5.80 15	5.41 0	6.01 15	6.29 25	6.42 50
6.66 50	6.52 25	6.31 15	6.12 0	6.09 15	5.97 25	5.80 50

ASSIGNMENT SHEET #3

15+50					
16+00					
16+50					
16+58					
17+00					
T.P.$_3$	7.24		6.16		
T.P.$_4$	6.81		4.04		
T.B.M.$_1$			0.30		1298.553

SAME

7.40	7.21	7.07	6.57	7.00	6.81	6.62
50	25	15	0	15	25	50
8.84	8.25	8.00	7.58	7.61	7.02	5.81
100	50	15	0	15	50	100
9.16	8.32	8.21	7.91	7.85	7.52	6.25
100	50	15	0	15	50	100
9.50	8.67	8.35	7.98	7.78	7.42	7.00
100	50	15	0	15	50	100
9.88	8.91	8.50	8.16	8.00	7.20	7.02
100	50	15	0	15	50	100

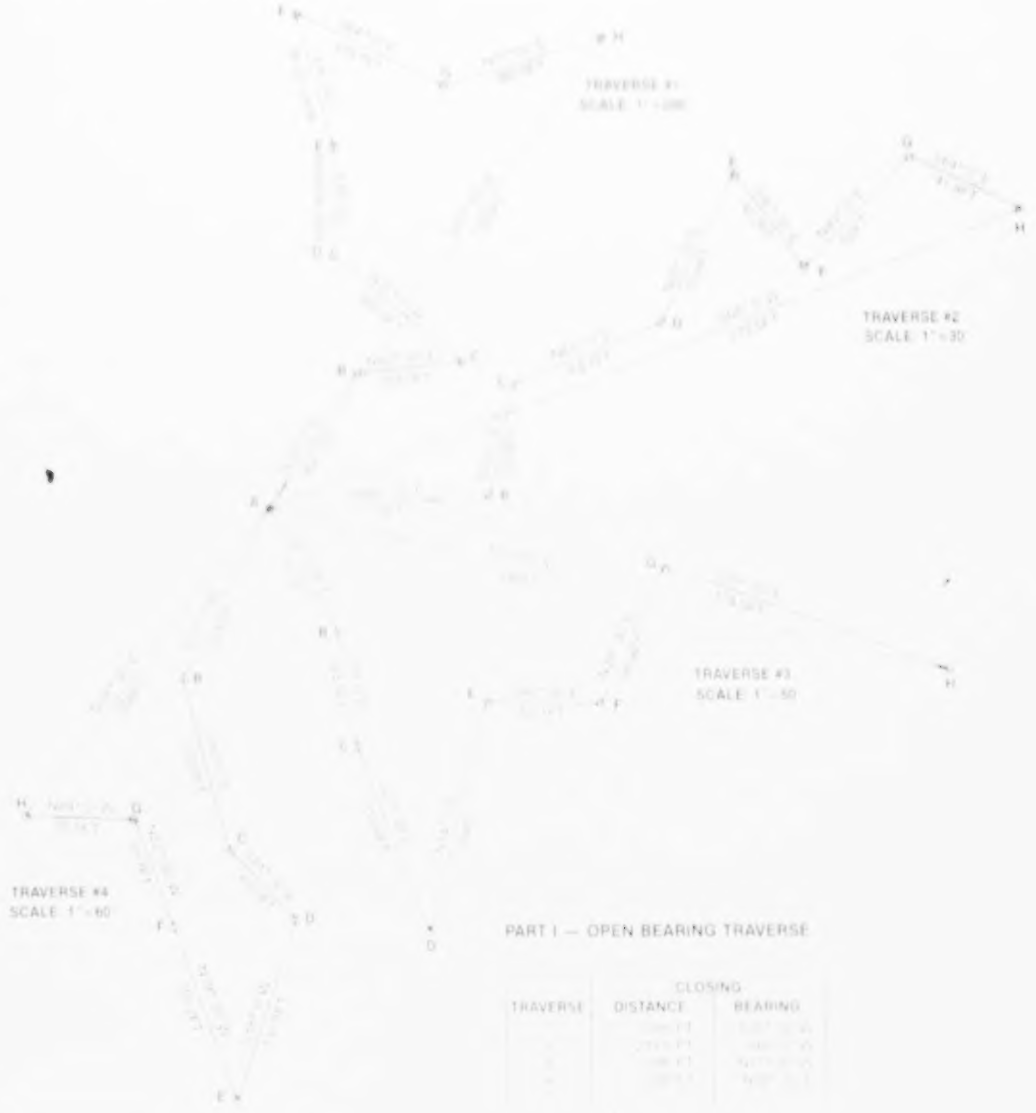
T/ROCK
T/FOUNDATION
SAME T.B.M. @ ON PG. 28

TRANSPORTATION MAPPING
UNIT IX

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART I: Open Bearing Traverses


TRAVERSE #1
SCALE 1"=200'
TRAVERSE #2
SCALE 1"=30'
TRAVERSE #3
SCALE 1"=50'
TRAVERSE #4
SCALE 1"=60'
A
B
C
D
E
F
G
H

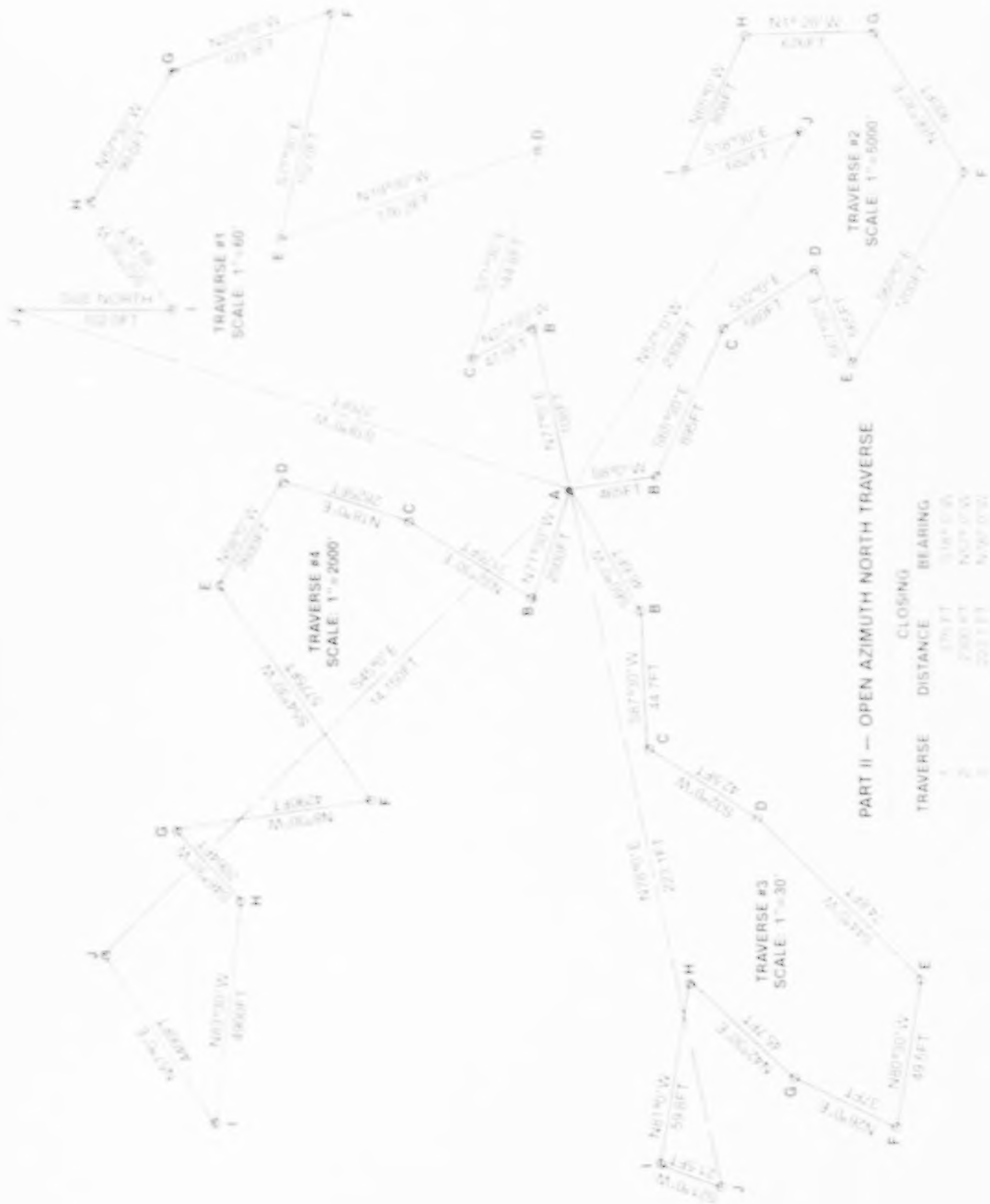
PART I — OPEN BEARING TRAVERSE

TRAVERSE	CLOSING	
	DISTANCE	BEARING
[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART II: Open Azimuth North Traverses


TRAVERSE #1
SCALE: 1" = 60'
S18°0'W
376FT
DUE NORTH
103.9FT
N57°0'W
90.0FT
N25°0'E
109.3FT
S77°0'E
102.0FT
N18°0'W
136.3FT
S71°30'E
144.8FT
N57°30'W
47.0FT
N77°0'E
109FT
TRAVERSE #2
SCALE: 1" = 5000'
N57°0'W
2300FT
S8°0'W
465FT
S65°30'E
895FT
S32°0'E
585FT
S67°30'E
565FT
S60°0'E
1200FT
N38°30'E
900FT
N1°30'W
630FT
N60°0'W
900FT
S38°30'E
585FT
TRAVERSE #3
SCALE: 1" = 30'
S60°0'W
45.5FT
S87°30'W
34.7FT
S32°0'W
42.5FT
S45°0'W
74.8FT
N80°30'W
49.5FT
N28°0'E
37FT
N42°30'E
45.7FT
N81°0'W
59.8FT
S21°0'E
21.5FT
N76°0'E
223.1FT
TRAVERSE #4
SCALE: 1" = 2000'
N71°30'W
2500FT
N32°30'E
3775FT
N15°0'E
2650FT
N56°0'E
2600FT
S54°30'W
5775FT
N3°0'W
4250FT
S45°0'W
2750FT
N83°30'W
4900FT
N57°0'E
4400FT
S45°0'E
14,150FT
A
B
C
D
E
F
G
H
I
J

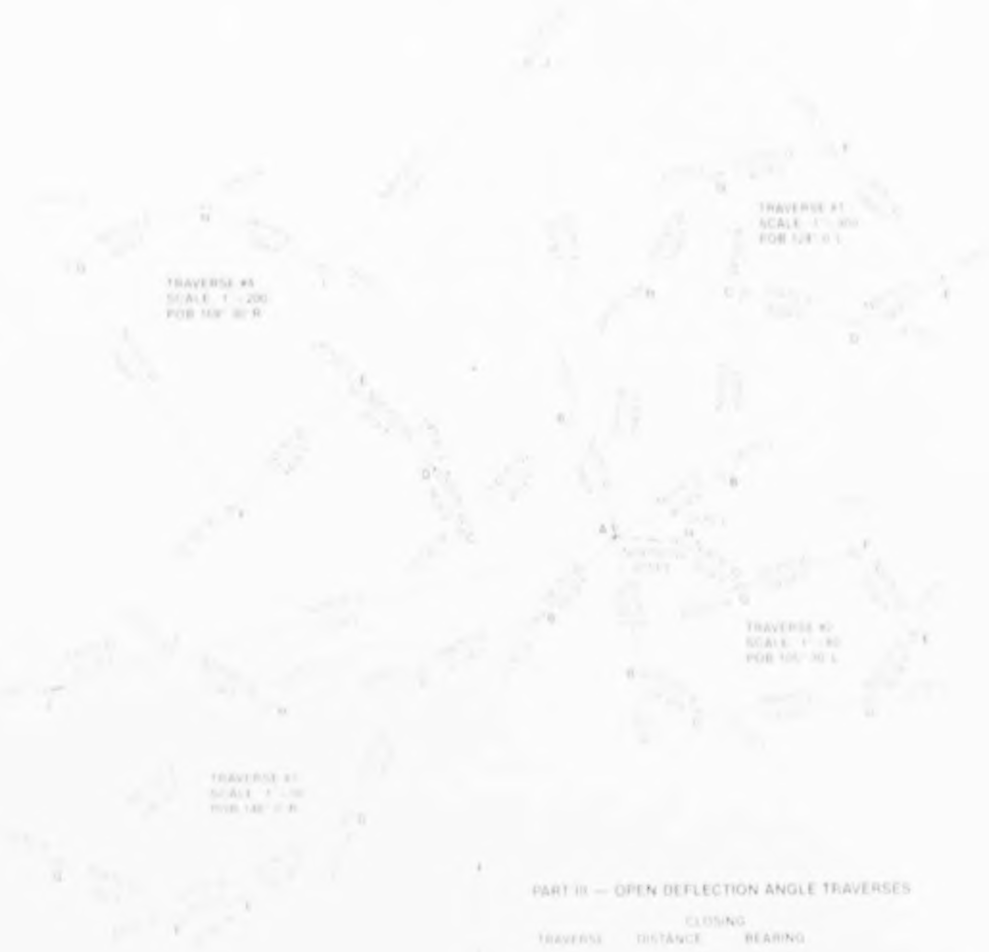
PART II — OPEN AZIMUTH NORTH TRAVERSE

TRAVERSE	CLOSING DISTANCE	CLOSING BEARING
1	376 FT	S18°0'W
2	2300 FT	N57°0'W
3	223.1 FT	N76°0'W
4	14,150 FT	S45°0'E

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART III: Open Deflection Angle Traverses


TRAVERSE #4
TRAVERSE #1
TRAVERSE #2
TRAVERSE #3

PART III — OPEN DEFLECTION ANGLE TRAVERSES

	CLOSING	
TRAVERSE	DISTANCE	BEARING
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

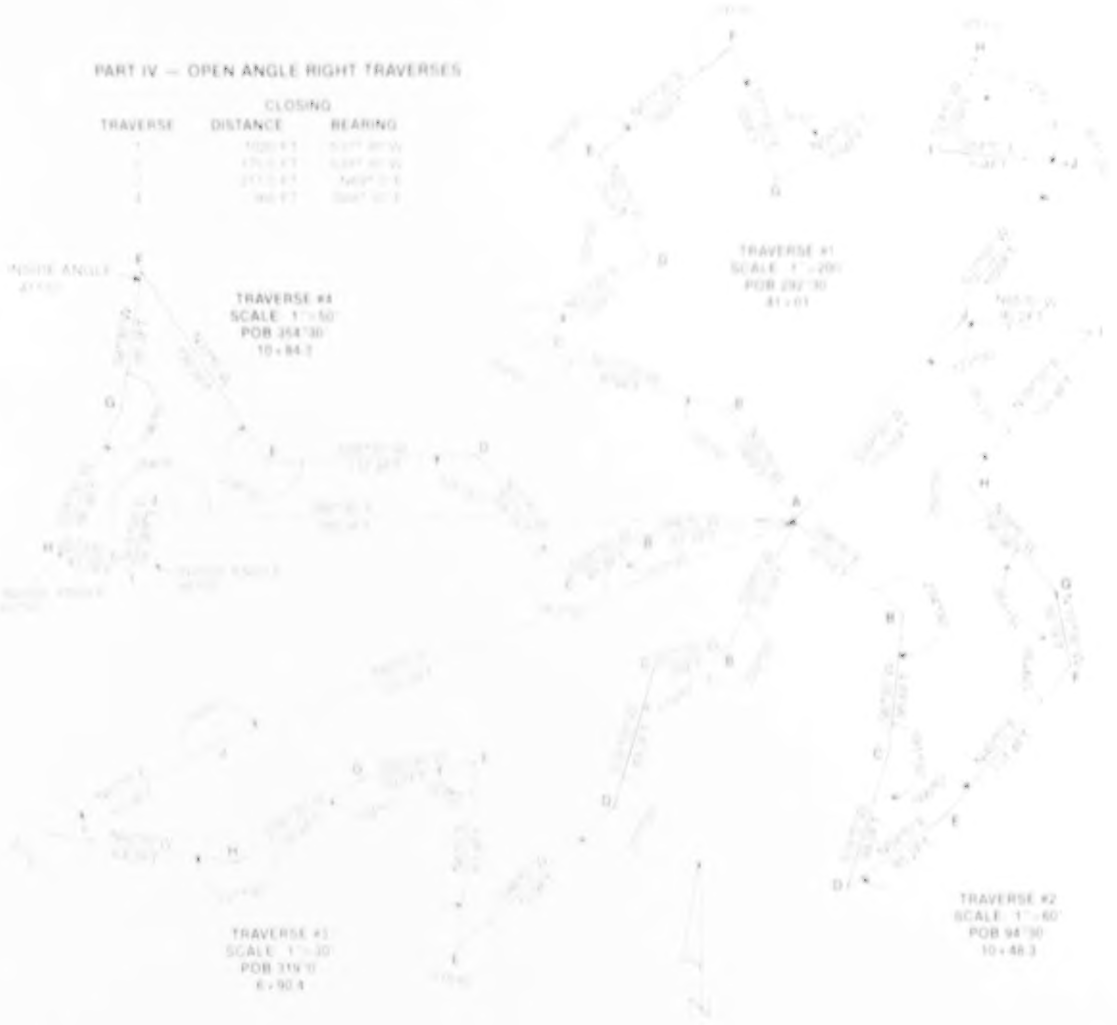
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART IV. Open Angle Right Traverses

PART IV — OPEN ANGLE RIGHT TRAVERSES

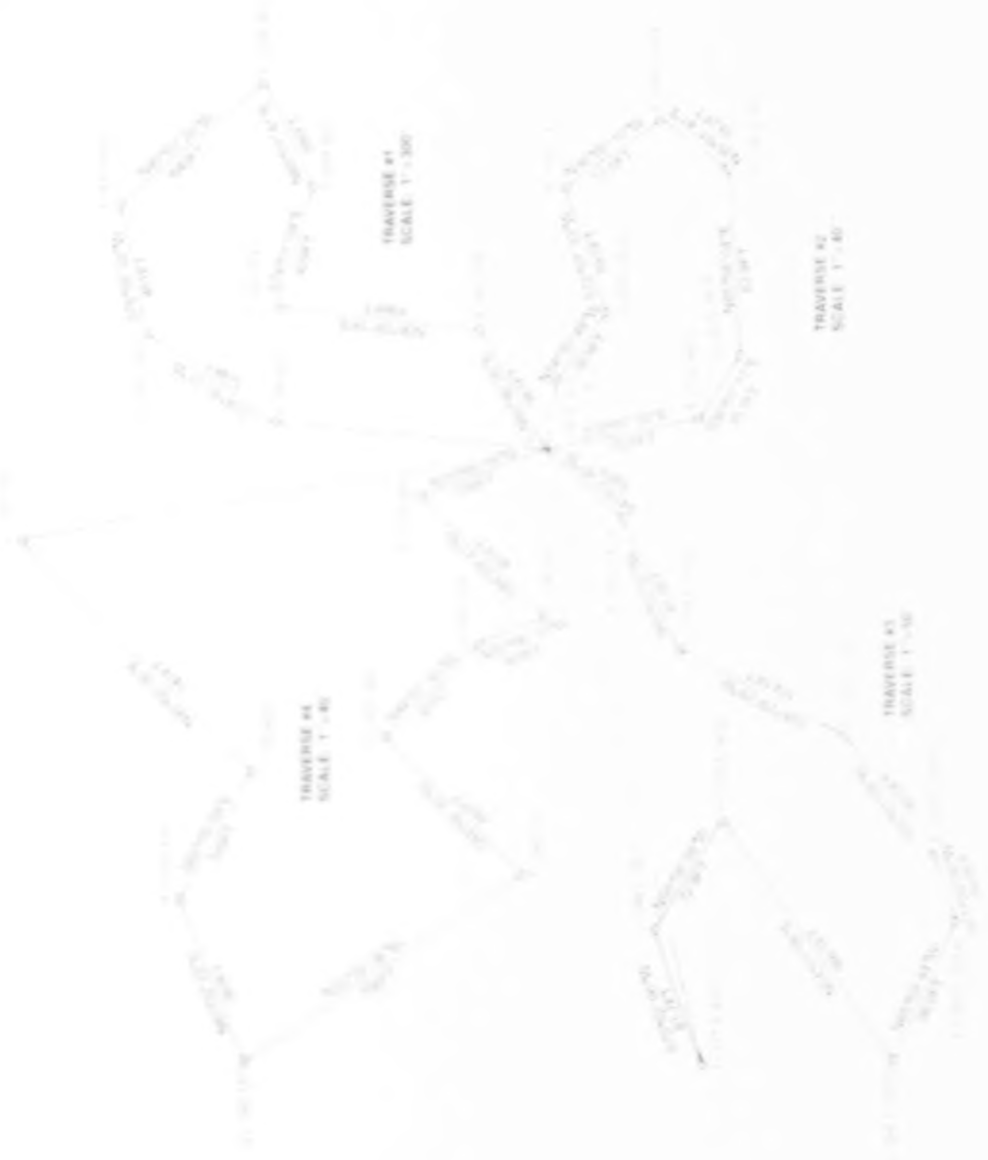
TRAVERSE	CLOSING DISTANCE	CLOSING BEARING
1	1020 FT	S37° 30' W
2	175.0 FT	S38° 30' W
3	217.0 FT	N49° 0' E
4	98 FT	S84° 0' E


TRAVERSE #1
SCALE 1" = 200'
POB 292°30'
41+01
TRAVERSE #4
SCALE 1" = 50'
POB 354°30'
10+84.3
INSIDE ANGLE
TRAVERSE #2
SCALE 1" = 60'
POB 94°30'
10+48.3
TRAVERSE #3
SCALE 1" = 30'
POB 319°0'
6+90.4
A
B
C
D
E
F
G
H

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART V. Open Traverses by Coordinates


TRAVERSE #1
SCALE: 1"=300'
TRAVERSE #2
SCALE: 1"=40'
TRAVERSE #3
SCALE: 1"=50'
TRAVERSE #4
SCALE: 1"=40'

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1 — Part V (continued)

Traverse #1

Course	Length	Bearing
A-B	461	N 60°46′00″ E
B-C	698	N 06°29′39″ E
C-D	429	S 74°01′04″ E
D-E	386	N 65°01′41″ E
E-F	640	N 40°03′28″ W
F-G	451	S 78°05′30″ W
G-H	524	S 34°30′31″ W

Traverse #2

Course	Length	Bearing
A-B	70.5	S 10°57′33″ E
B-C	35.1	S 56°51′11″ E
C-D	83.9	N 85°58′04″ E
D-E	39.2	N 35°01′41″ E
E-F	51.6	N 36°00′10″ W
F-G	59.0	S 72°01′33″ W
G-H	38.9	N 54°30′49″ W

Traverse #3

Course	Length	Bearing
A-B	58.0	S 43°02′40″ W
B-C	81.5	S 65°57′07″ W
C-D	104.5	S 26°29′29″ W
D-E	85.0	S 53°02′09″ W
E-F	39.0	S 71°28′20″ W
F-G	86.0	N 65°59′44″ W
G-H	166.5	N 54°01′05″ E
H-I	72.9	N 58°58′08″ W
I-J	81.7	S 70°02′06″ W

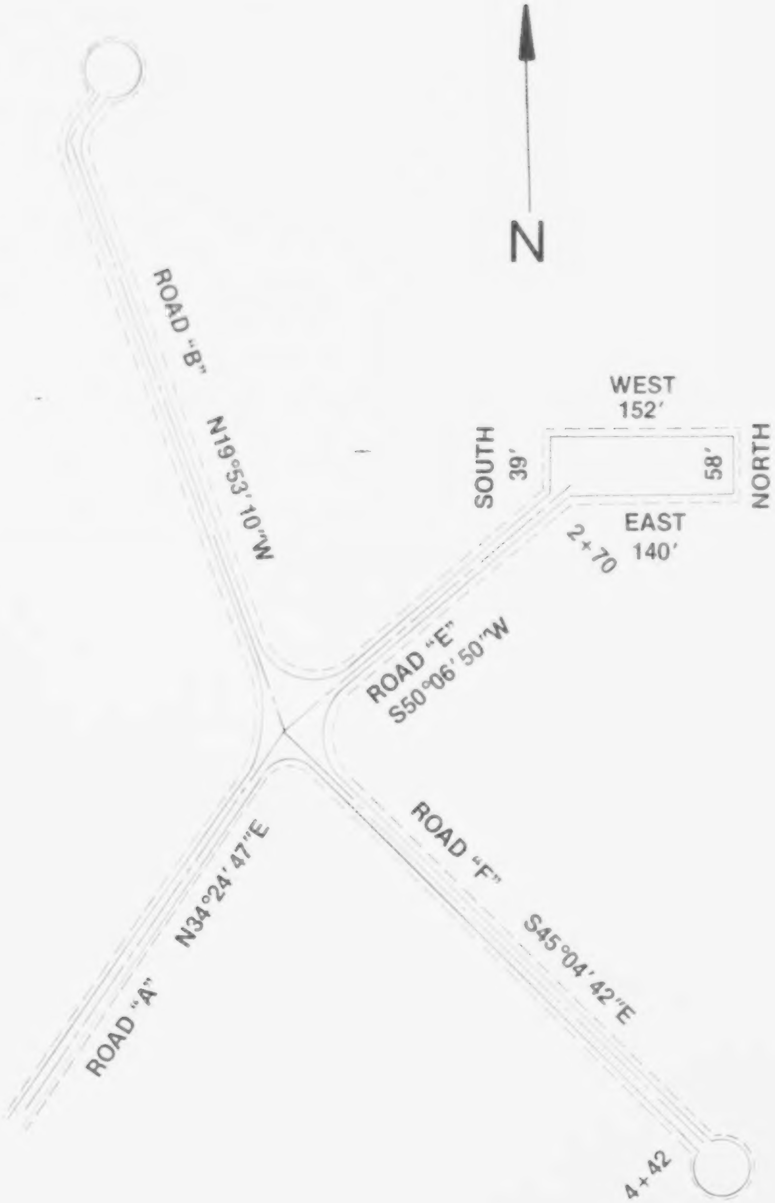
Traverse #4

Course	Length	Bearing
A-B	304	N 19°58′59″ W
B-C	401	S 44°29′41″ W
C-D	163	N 20°06′12″ W
D-E	301	N 44°27′43″ W
E-F	442	S 44°54′30″ W
F-G	758	N 33°32′36″ W
G-H	387	N 67°32′22″ E
H-I	339	S 60°29′09″ E
I-J	741	N 45°00′00″ E

TRAVERSE	CLOSING	
	DISTANCE	BEARING
1	933′	S 05°47′02″ W
2	31.2′	N 82°04′40″ W
3	360.2′	N 75°30′44″ E
4	1210′	S 09°48′18″ E

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2


N
ROAD "B"
N19°53'10"W
WEST
152'
SOUTH
39'
58'
NORTH
EAST
140'
2+70
ROAD "E"
S50°06'50"W
ROAD "F"
S45°04'42"E
ROAD "A"
N34°24'47"E
4+42

Assignment Sheet #3 — Evaluated to the satisfaction of the instructor.

TRANSPORTATION MAPPING
UNIT IX

NAME ____________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. A large one-sided arrow used for example to indicate the beginning and end of construction

_____b. The line at the edge of a mapped area which aids in fitting two drawings together

_____c. A right acquired by public authority to use or control property for a designated purpose

_____d. The intersection angle of a highway curve; also called the Delta Δ angle

_____e. The slope of cut and fill from the road expressed in feet of horizontal run to feet of vertical run

_____f. The legal right to cross the lands of another; used to indicate a strip of lane for a road, railroad, or power line

_____g. A pit or bank from which material is taken for use in filling or embanking

_____h. The length of a highway curve from beginning to end measured along the arc

_____i. The point at which a highway curve begins

_____j. A drawing that shows the summary of earthwork over an entire project, including balance areas and quantities of earth grouped by soil classification, usually calculated by computer

_____k. A line on a traverse

_____l. The angle of a chord (from the preceding one) that connects station points along the centerline of a highway or railroad

_____m. In surveying an angle that veers to the right or left of a straight line, often the centerline of a highway, powerline, etc.

1. Angle of repose
2. Borrow pit
3. Central angle
4. Course
5. Curve length
6. Deflection angle
7. Degree of curve
8. Easement
9. Flag
10. Hub
11. Mass diagram
12. Match line
13. Offset line
14. Point of curve
15. Right-of-way

TEST

______n. The shape of a linear feature such as a road or highway (in profile) as it crests a hill or creates a sag in a valley or depression

______o. Adjusting the slope perpendicular to centerline for the purpose of counteracting centrifugal force

______p. The centerline of a linear survey (highway, pipeline, etc.)

______q. Straight line of a survey

______r. An easement for cut and fill

______s. A portion of a roadbed prepared as a foundation for the base or surface course

______t. A substantial square stake, usually driven flush with the ground, with a tack marking the survey point

______u. A supplementary line close to and roughly parallel with a main line, to which it is referenced by measured offsets

16. Slope easement
17. Subgrade
18. Superelevation
19. Tangent
20. Transit line
21. Vertical curve

2. State the purpose of route surveys.

____

3. Select true statements concerning the fundamentals of a route survey by placing an "X" next to the true statements.

______a. The most common use of route surveys is for dam and reservoir location and construction.

______b. A closed traverse survey is the method recommended for use on route surveys.

______c. Traverses are first staked out as a series of straight lines.

______d. Curves are employed at the points of change in the traverse to allow for flow of travel.

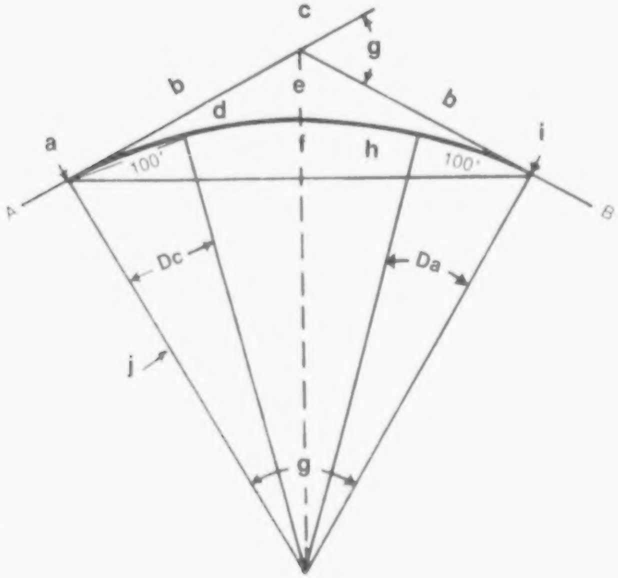
4. Complete the following statements concerning superelevated roadways by circling the correct words.

a. A roadway is superelevated when the outside edge is (**lower, higher**) than the inside edge.

b. The purpose for superelevating a roadway is to allow for easy maneuvering of vehicles through (**horizontal, vertical**) curves.

TEST

5. Identify the following elements on the horizontal circular curve shown: R, PI, I or Δ, PC, PT, L, T, C, E, and M.



a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

i. ______________________

j. ______________________

6. Complete the following mathematical formulas used for computing a horizontal curve.

a. $T = R \cdot \tan \frac{(\quad)}{2}$

b. $L = 100 \frac{I}{(\quad)}$

c. $\frac{D^\circ}{360^\circ} = \frac{100}{2\pi(\quad)}$

TEST

7. Select true statements concerning circular curve layout by tangent offsets by placing an "X" next to the true statements.

   ______a. Is used when precise layout of a curve is critical.

   ______b. PC, PT, and the external point are still located by transit method.

   ______c. Tangent offsets are used to locate intermediate points on the curve.

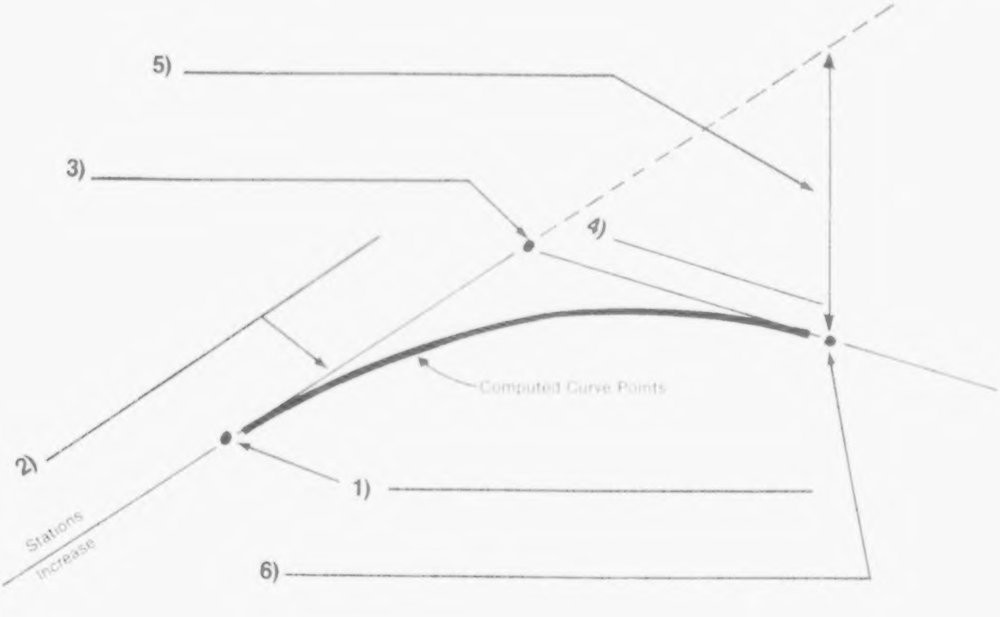
8. Complete the following statements concerning vertical curves by correctly filling in the blanks.

   a. Are the shapes of the road or highway as they ______________________.

   b. The two general types are ____________ and sags.

   c. Are calculated and the elevation points are plotted by ____________.

   d. Locate the following points on the vertical curve shown: PVC, PVI, PVT, G_1, G_2, and H.



TEST

9. Complete the following statements concerning plan views for route surveys by correctly filling in the blanks.

   a. Are constructed from ____________.

   b. Show the following: (list five)

      1) ____

      2) ____

      3) ____

      4) ____

      5) ____

   c. Are placed in the ____________ portion of the plan-profile paper.

   d. Each sheet contains ____________ stations when the scale is 1" = 100 feet.

   e. Each sheet should begin and end with ________________________.

10. Select true statements concerning characteristics of profiles for a route survey by placing an "X" next to the true statements.

_____a. Profiles are drawings showing cross sections along a certain survey line.

_____b. Profiles are plotted from level notes or interpolated from the contour map.

_____c. Level notes show elevations along the survey line.

_____d. Profiles are plotted on standard plan-profile paper in the ungridded portion.

_____e. The horizontal and vertical scales should be the same scale.

_____f. Horizontal scale is exaggerated because the horizontal distances are greater as compared to the change in elevation.

_____g. The preferred horizontal to vertical scale ratio is 50:1.

_____h. Horizontal axis is twice the scale of the plan view.

_____i. Only full stations are labeled and shown as tick marks on the accented grid lines.

_____j. First station should be set over one grid line from the vertical scale.

TEST

_____k. Station numbers increase from right to left.

_____l. Station limits of the profile must correspond exactly to those of the plan portion of the sheet.

_____m. Elevations for plotting profiles are obtained from the contour map in the plan view.

_____n. Elevation data are indicated on both left and right sides of the sheet.

11. Select true statements concerning characteristics of cross sections for a route survey by placing an "X" next to the true statements.

_____a. Represent a cut 90° to the plan view and are used to show elevations.

_____b. Are usually plotted on 50 units to the inch cross-section paper.

_____c. Are arranged consecutively by stations which were reported in the field notes.

_____d. Are usually plotted from bench level circuit field notes.

_____e. Horizontal and vertical scales may or may not be the same.

_____f. The scales used depend on the accuracy required in computing the cross-sectional areas and upon the relief.

_____g. Cross sections are taken from the center line out in each direction from the center line or taken out from the survey line of a street or borrow pit.

_____h. Spacing of cross sections is determined by the engineers — the further apart, the more accurate the estimation of volume.

_____i. Cut and fill areas should be cross hatched or shaded with the cut area and the fill area shaded the same.

12. Complete the following statements concerning field note reduction for a cross section by circling the correct words.

a. (**Right, Left**) hand sheet shows notes used in determining the height of the instrument.

b. (**Right, Left**) hand sheet shows elevation points on which a reading was taken, the distance out from the control line, and the rod reading.

c. Only the distance and (**rod reading, elevation**) are used in plotting the cross section.

TEST

13. Complete the following statements concerning plotting cross sections by correctly filling in the blanks.

    a. Each section is plotted individually beginning at the top and ____________-hand side of sheet with station 0+00.

    b. Sections are then plotted under each other in order of ____________ numbers.

    c. Each point on the cross section is plotted by using a ____________ scale for elevation and a ____________ scale for the distance out.

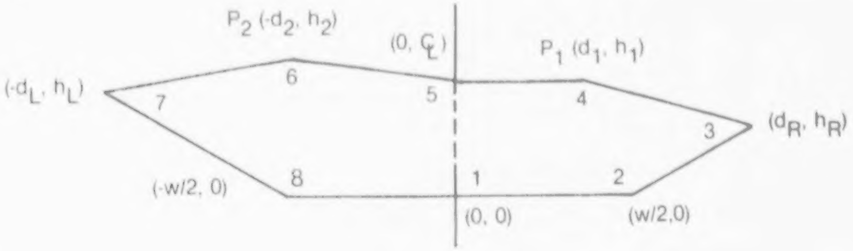
    d. Each point is labeled with coordinates. This coordinate number consists of a horizontal line with the distance out written on the ____________ and the elevation written on the ____________.

    e. A vertical scale different from that of the horizontal is used to accent the ____________ ____________.

14. Distinguish between the three methods used to determine areas of cross sections by placing the following letters next to the correct illustrations and formulas:

- X — Three-level section, pure cut **or** fill
- Y — Polygon section, pure cut **or** fill
- Z — Three-level section, cut **and** fill mixed

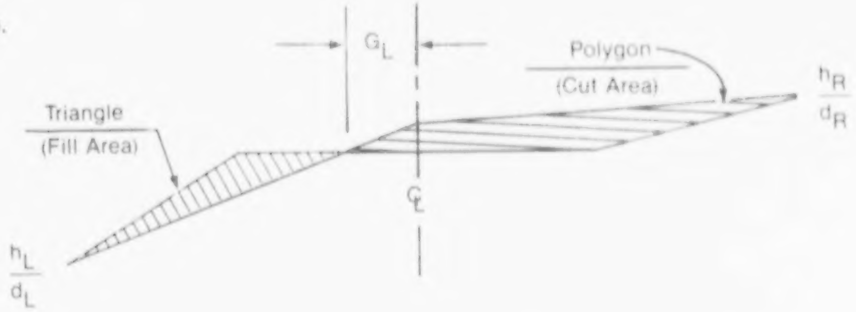
_____a.

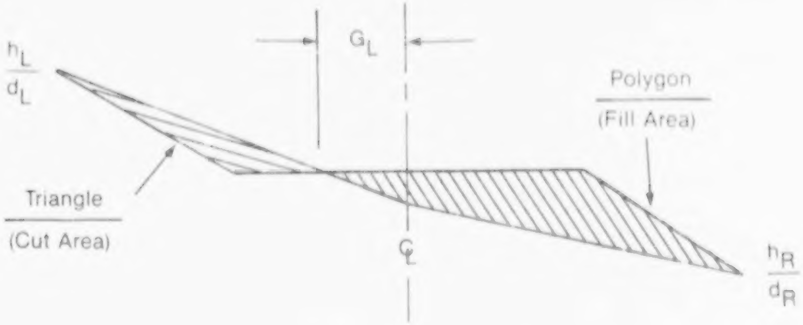


$$A = (.5)\left[\frac{w}{2}(h_R + h_L) + d_1(\text{℄} - h_R) + d_2(\text{℄} - h_L) + d_R h_1 + d_L h_2\right]$$

TEST

_____b.


G_L
Polygon
(Cut Area)
h_R
d_R
Triangle
(Fill Area)
℄
h_L
d_L

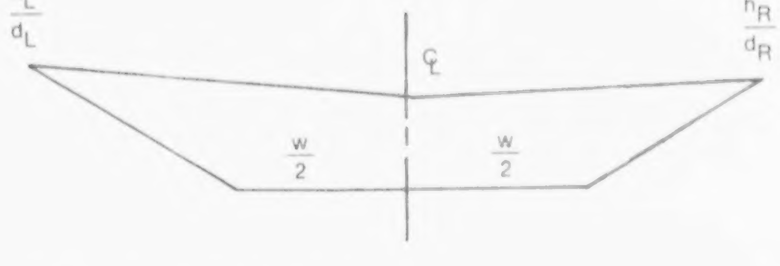

h_L
d_L
G_L
Polygon
(Fill Area)
Triangle
(Cut Area)
℄
h_R
d_R

Grade point $(G_L) = \dfrac{\text{℄}\, d_L}{h_L + \text{℄}}$

$A_{\triangle} = (.5)\, \dfrac{w}{2}\, h_L \cdot \dfrac{\text{℄}\, d_L\, h_L}{h_L + \text{℄}}$

$A_P = (.5)\, \dfrac{w}{2} h_R + \text{℄}\, d_R + \dfrac{\text{℄}^2\, d_L}{h_L + \text{℄}}$

_____c.


h_L
d_L
℄
h_R
d_R
w/2
w/2

Area $= (.5)\left[\dfrac{w}{2}(h_L + h_R) + \text{℄}\,(d_L + d_R)\right]$

TEST

15. State the formula for calculating earth volume.

    a. Volume by average end area — ____________________

    ____

    b. Volume by prismoidal method — ____________________

    ____

    c. Prismoidal correction — ____________________

    ____

16. List five drawings included in a set of highway plans.

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

    e. ____________________

17. Select from the list on the right the common horizontal and vertical scales used in transportation mapping for rural and urban areas.

    a. Rural areas

        1) Horizontal scale — ____________

        2) Vertical scale — ____________

    b. Urban areas

        1) Horizontal scale — ____________

        2) Vertical scale — ____________

1" = 1"
1" = 1'
1" = 5'
1" = 10'
1" = 20'
1" = 25'
1" = 50'
1" = 100'
1" = 150'

18. List four items that appear on a typical title sheet for a set of highway plans.

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

TEST

19. Select true statements concerning detail sheets by placing an "X" next to the true statements.

_____a. Detail sheets show information necessary for constructing a special item.

_____b. Each detail must be shown on a separate sheet.

_____c. Details do not need to be arranged in any special order.

_____d. Interchange details may have to be put on more than one sheet. Match lines are clearly marked on each sheet.

20. Complete the following statements concerning the drafting of plan views, profiles, and cross sections by circling the correct words.

a. Drafting plan views

1) Begin and end the sheet on stations divisible by (**five, ten**).

2) Use (**light, heavier**) line work for the planned construction feature.

3) Use pen size number (**0, 1, 3**) for survey and curve lines.

b. Drafting profiles

1) Correspond stations from the (**plan view, cross section**).

2) Plot ground line under roadway profile grade as a (**dotted, dashed**) line or light thin line.

3) Show elevations to the (**tenth, hundredth**) of a foot.

4) Show grades to the (**hundredth, thousandth, ten thousandth**) of a percent.

5) Arrange profile sheet with two inches left on bottom of sheet for the (**earthwork breakout, curve data**).

c. Drafting cross sections

1) Draw in (**pen, pencil**).

2) Note scale and type of cross section at the upper (**left, right**) corner of the sheet.

3) Write area of each section (**within, below**) the section and state if it is cut or fill.

4) Write volume of earth (**between the sections, in a chart at the bottom of the page**) and state if it is cut or fill.

5) Connect first and last points of each section by a (**dotted, dashed**) line.

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

21. Layout an open traverse using several methods. (Assignment Sheet #1)

22. Layout a survey alignment for a road using bearings and coordinates. (Assignment Sheet #2)

23. Plot field notes for horizontal control, topography, profile, and cross section for a proposed road. (Assignment Sheet #3)

TRANSPORTATION MAPPING
UNIT IX

ANSWERS TO TEST

1. a. 9
   b. 12
   c. 8
   d. 3
   e. 1
   f. 15
   g. 2
   h. 5
   i. 14
   j. 11
   k. 4
   l. 7
   m. 6
   n. 21
   o. 18
   p. 20
   q. 19
   r. 16
   s. 17
   t. 10
   u. 13

2. For making studies for the location and construction of such public utilities as highways, railways, pipelines, canals, and power lines.

3. c, d

4. a. Higher
   b. Horizontal

5. a. PC
   b. T
   c. PI
   d. L
   e. E
   f. M
   g. I or △
   h. C
   i. PT
   j. R

6. a. I
   b. D
   c. R

7. b, c

8. a. Reach the top of a hill or bottom of a valley
   b. Crests
   c. Civil drafters
   d. 1) PVC
      2) G
      3) PVI
      4) G
      5) H
      6) PVT

ANSWERS TO TEST

9. a. Field notes
   b. Any five of the following:
      1) Contours
      2) Survey alignment (transit line)
      3) Trees
      4) Buildings
      5) Other roads
      6) Cultivated areas
      7) Station points
      8) Curve (horizontal) data
      9) All necessary horizontal control (bearings, distances, radii, angles)
   c. Ungridded
   d. 30
   e. Match lines

10. b, c, i, j, l, m, n

11. c, e, f, g

12. a. Left
    b. Right
    c. Elevation

13. a. Left
    b. Station
    c. Vertical, horizontal
    d. Bottom, top
    e. Elevation differentials

14. a. Y
    b. Z
    c. X

15. a. $V_E = L\left(\frac{A_1 + A_2}{2}\right)$
    b. $V_P = \frac{L}{6}(A_1 + 4M + A_2)$
    c. $V_C = V_E - V_P$

ANSWERS TO TEST

16. Any five of the following:
    (NOTE: Others may be included in your area.)
    a. Title sheet
    b. Typical section and general notes
    c. Estimate quantities
    d. Structure quantities sheets
    e. Tabulation sheets
    f. Detail sheets
    g. Pit location sheets
    h. Major structure detail sheets
    i. Plan and profile sheets (line sheets)
    j. Cross section sheets
    k. Landscaping and sprinkler plans
    l. Traffic control signs
    m. Standard sheets

17. a. 1) 1" = 100'
    2) 1" = 10'
    b. 1) 1" = 50'
    2) 1" = 5'

18. Any four of the following:
    a. Project number
    b. State highway number
    c. County and state
    d. Location map
    e. Length and design data
    f. Index of sheets
    g. Approval blocks

19. a, d

20. a. 1) Five
    2) Heavier
    3) 3
    b. 1) Plan view
    2) Dashed
    3) Hundredth
    4) Ten thousandth
    5) Earthwork breakout
    c. 1) Pencil
    2) Right
    3) Within
    4) Between the sections
    5) Dashed

21.-23. Evaluated to the satisfaction of the instructor

MUNICIPAL MAPPING
UNIT X

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify symbols used in municipal mapping, research the plats for local utilities, and draft a map of all utilities for a local area. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to municipal mapping with the correct definitions.
2. List types of utilities.
3. List agencies who develop and maintain municipal maps.
4. List users of municipal maps.
5. Select from a list types of drawings used in municipal mapping.
6. List methods of presenting utilities on maps.
7. Select true statements concerning the surveying and mapping of municipal maps.
8. List support information needed to develop utility drawings for a specific area.
9. Complete statements concerning utility easements.
10. Match types of valves and valve housings with the correct definitions.
11. Match types of gas piping and devices with the correct definitions.

OBJECTIVE SHEET

12. List information included on utility drawings.
13. Match types of sewers and sewer lines with the correct descriptions.
14. Research the plats for local utilities. (Assignment Sheet #1)
15. Draft a map of all utilities for a local area. (Assignment Sheet #2)

MUNICIPAL MAPPING
UNIT X

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Take a field trip to a local utility company and visit the drafting department.
2. Invite a field engineer from a utility company to speak on how drawings are used in the field.
3. Make a listing of all utilities in your area that use drafters. Post their addresses.
4. Create a display with a set of drawings showing all the utilities to your school.
5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

INSTRUCTIONAL MATERIALS INCLUDED IN THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

  1. TM 1 — Typical Plan and Profile — Water System
  2. TM 2 — Typical Flow Diagram — Sewer Layout
  3. TM 3 — Typical Distribution Map — Electric
  4. TM 4 — Typical Obstruction Map — and Proposed Gas Sketch
  5. TM 5 — Typical Utility Easement Layout

D. Assignment sheets

  1. Assignment Sheet #1 — Research the Plats for Local Utilities
  2. Assignment Sheet #2 — Draft a Map of All Utilities for a Local Area

E. Test

F. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. Deaver, Rip. *Structural Drafting.* Houston, TX: Gulf Publishing Co., 1977.

B. *Drafting Standards.* Public Service Company of Colorado, Denver Electrical and Gas Distribution Centers, 1980.

C. *Drafting Standards.* Public Service Company of Oklahoma, Tulsa, 1969.

D. *Drafting Standards.* City of Stillwater, Oklahoma.

E. *Plat Standards for Utility Plans.* City of Boulder, Colorado, 1982.

F. Moffit, Francis H., and Harry Bouchard. *Surveying*, 7th ed. New York: Harper & Row Publishers.

MUNICIPAL MAPPING
UNIT X

INFORMATION SHEET

I. **Terms and definitions**

   A. Base map — A map that shows roads, highways, ditches, rivers, lakes, and subdivisions

   B. Distribution map — A map that contains one line configurations of all overhead and underground primary and secondary utility lines

   C. Flow diagram — Drawing that shows a system in a symbolic manner as opposed to conventional mapping format

   D. Index map — A map that shows the location of all plats and plat numbers

   E. Municipal mapping — The recordation of public utilities such as gas, electric, water, and sewer lines onto a map for public record

II. **Types of utilities**

   A. Gas

   B. Electric

   C. Water

   D. Sewer

   E. Telephone

   F. Cable for television

   G. Drainage

III. **Agencies who develop and maintain municipal maps**

   A. Public service companies

   B. Rural power companies

   C. Department of public works

   D. Department of waste management

   E. Telephone company

   F. Water department

INFORMATION SHEET

IV. **Users of municipal maps**

A. Architects

B. Land developers

C. City planners

D. Telephone company

E. Builders

F. Zoning department

G. Individuals

H. Engineers

I. Surveyors

V. **Types of drawings used in municipal mapping** (Transparencies 1-4)

A. Plan

B. Profile

(NOTE: Some utilities require engineering plan and profiles, while others such as water and telephone can be located by easements over lots on plat maps.)

C. Plat maps

D. Base maps

E. Flow diagrams

F. Bill of materials (quantity sheets)

G. Distribution maps

H. Obstruction maps

I. Index maps

VI. **Methods of presenting utilities on maps**

A. Separate maps for each utility

B. Base map with overlays to show the location of each utility

INFORMATION SHEET

C. Composite maps

D. CAD — Each utility can be stored on a separate layer in the computer. A computer printout can provide just the base map or the location of as many utilities as the operator wants plotted out.

VII. Surveying and mapping municipal maps

A. Horizontal control monuments established by triangulation and traverse are of first and second class order accuracy.

B. Vertical control benchmarks are established by differential levels.

C. Base maps are compiled to provide a common basis for topographic maps, property maps, subdivision maps, and maps showing the position of utility lines.

D. Scales of base maps vary depending on the density of land use from 1 in = 50 ft, 1 in = 100 ft, and 1 in = 200 ft.

E. Base maps will include the state plane coordinates.

F. Base maps are generally laid out in ¼ section showing all streets, highways, railroads, etc.

(NOTE: Some rural maps cover a full section.)

G. Topography is at a scale of 1 in = 200 ft with a contour interval of 2 or 5 feet.

H. Various color codes are used to represent different utilities.

(NOTE: It is recommended that the colors used be reproducible by a diazo printer. Utility lines should be labeled in addition to the color identification.)

Example: The following color code is used by one company. This varies between companies.

1. Gas — yellow
2. Water — red
3. Sanitary and storm sewer — orange
4. Telephone — green
5. Electric — purple
6. Western Union — yellow with black border on each side of yellow

INFORMATION SHEET

7. Steam — blue and yellow dashed

8. Petroleum pipelines — helio

9. Radar and missile cables — yellow and helio dashed

VIII. **Support information needed to develop utility drawings for a specific area**

A. Adjacent plats

B. Miscellaneous information on subs, ordinances, and deed pertaining to plat to be drawn

C. Aerial photos

D. Railroad maps

E. Highway maps

F. U.S.G.S. maps

G. Easement file

H. Transmission pipeline plats

I. Obstruction maps

J. Electric transmission right-of-ways

IX. **Utility easements** (Transparency 5)

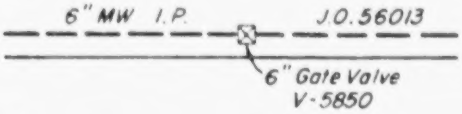
A. Are usually shown on the subdivision plat to indicate the location of any and all utilities.

(NOTE: This location is not generally used for gas mains.)

B. Generally each utility will be located in a standard location with reference to the front property line.

X. **Types of valves and valve housings**

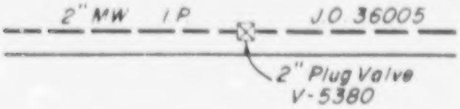
A. Gate valve — Used for infrequent start-stop operations; has a disk to stop flow through valve



B. Ball valve — Used for quick start-stop operations; has a ball to stop flow through valve

INFORMATION SHEET

C. Plug valve — Used for quick start-stop operations; has a slotted core or plug that stops flow when turned 90°



D. Globe valve — Used for flow regulation, throttling, and frequent operation

E. Check valve — Used to prevent backflow; available as swing check or lift check for different applications

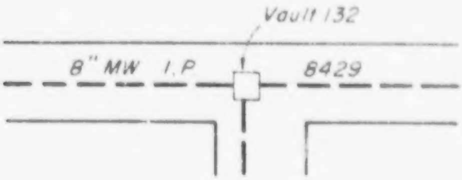
F. Pressure safety valve — Used to protect equipment and workers from sudden and dangerous excess pressures

G. Pressure regulator valve — Used to automatically maintain accurate, constant, and uniform flow in a line

H. Valve box — A small box designed to house a valve up to and including 6"

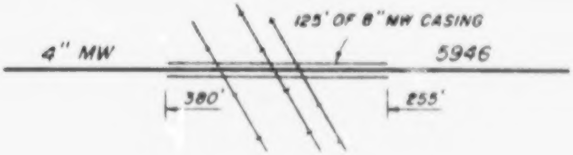
I. Valve vault — An underground structure designed to house a valve 8" and larger or a series of valves

(NOTE: Vaults are usually built of reinforced concrete and are constructed in several standard sizes.)



XI. **Types of gas piping and devices**

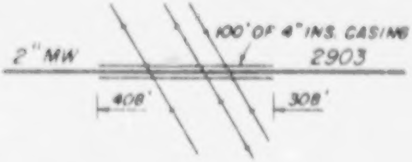
A. Casing — Pipe sleeve generally used for railroad, highway, ditch, and bridge crossings to enclose the main in a protective casing



INFORMATION SHEET

B. Casing, insulated — Same as casing, but carrier is insulated from pipe with insulated spacers and bushings

(NOTE: All casing should be insulated from carrier pipe.)

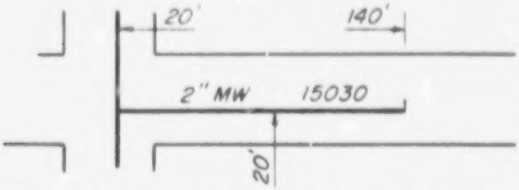

100' OF 4" INS. CASING
2" MW
2903
408'
308'

C. Control line — A small pipe, usually ¾" or 1 ¼", used in connection with a regulator station to control pressure rather than to transport gas

1¼" Control Line
18462

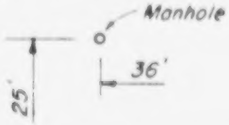
D. Cover — Distance between top of pipe and street surface

E. Main ending — Distance to end of main from a stationary point such as property line, pole line, etc.

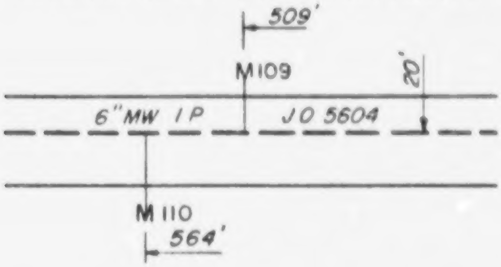

20'
140'
2" MW
15030
20'

F. Manhole — An opening at the top of a valve vault making housed valves accessible at all times

(NOTE: In some areas the entire structure is referred to as the "manhole.")


Manhole
36'
25'

G. Marker, pipe line — A wooden post 8' in length with metal warning signs on two sides in line with the pipeline installed directly over the main where measurements from a permanent object or source are not available


509'
M109
20'
6" MW IP
JO 5604
M110
564'

INFORMATION SHEET

H. Meter — A device for measuring customer gas usage in cubic feet

I. Meter riser — A portion of piping vertical to the ground used for the installation of an outside meter

J. Nipple — A short piece of pipe

K. Pole line — Power or telephone line usually set 1 foot on road side of property line

L. Regulator station — Equipment designed to reduce and control gas pressure manually, automatically, or by remote control

(NOTE: These vary in size from a small station on a pole (pole type) to a major station requiring a complete building and plot of ground.)

M. Riser — Gas piping installed in a vertical position, usually exposed and fastened to building walls, poles, or other rigid structures

N. Service, low pressure — That portion of pipe used for transporting low pressure gas from the main to the meter

O. Service regulator — A device designed to reduce gas pressure and maintain constant pressure for customer's use; located between the service terminal valve and the gas meter

XII. Information included on utility drawings

A. Easement dimensions

B. Symbols and labels

C. Bill of materials

D. Schematic symbols for fittings, valves, sewer lines, water lines, and taps

E. Manhole locations

F. Distance of gas main, sewer line, or water tap from property line

G. Sizes and types of valves and lines

H. Locations of obstructions (Transparency 4)

I. Existing and proposed utility lines

J. Underground cables

K. Street lighting symbols (depending on type of drawing)

INFORMATION SHEET

XIII. Types of sewers and sewer lines

(NOTE: Most sewers use carbon steel or cast iron pipe.)

A. Storm sewer — Collects rain wash and fire water

B. Process sewer — Collects water from drains of equipment, drips from pumps, and other dirty drains

C. Combined sewer — Collects both storm and process sewers utilizing only one piping system

D. Sanitary sewer — Carries human wastes

E. Funnel — Liquid collection point that usually projects about 2" above the finished grade

F. Branches — Lines (4" minimum) that collect from various drain funnels or catch basins and tie to sublaterals

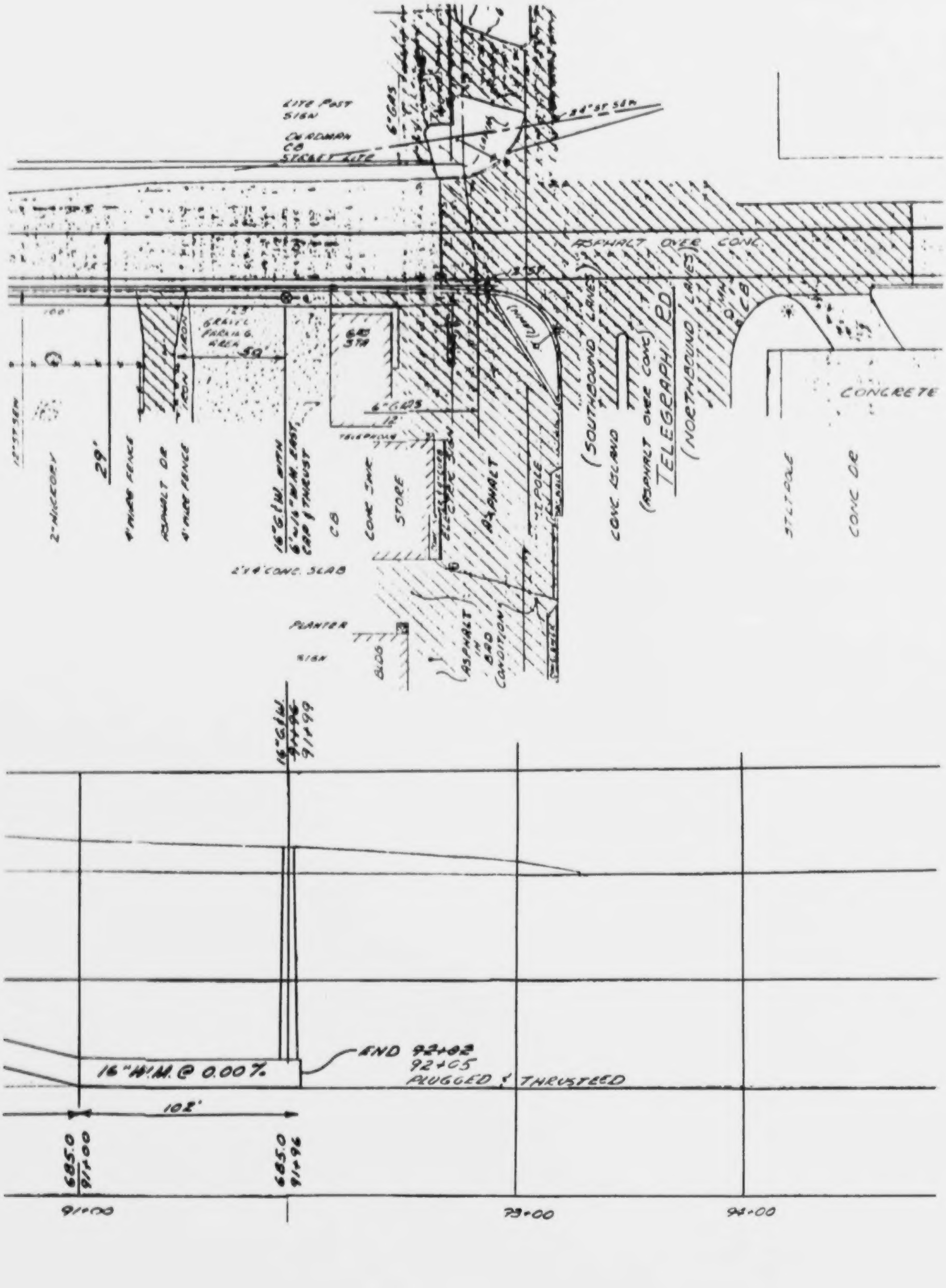
G. Laterals — Sewer lines collecting from two or more sublaterals and discharging to mains through a sealed manhole

H. Sewer mains — Lines that collect flow from two or more laterals and are usually located in roadway easements; are sealed at regular intervals with manholes to prevent the spread of fire or gas backup

I. Cleanouts — Openings located at the ends of branches and long line runs which allow the sewer to be cleaned by removing a plug and inserting a long flexible steel bar

Typical Plan and Profile

(Water System)

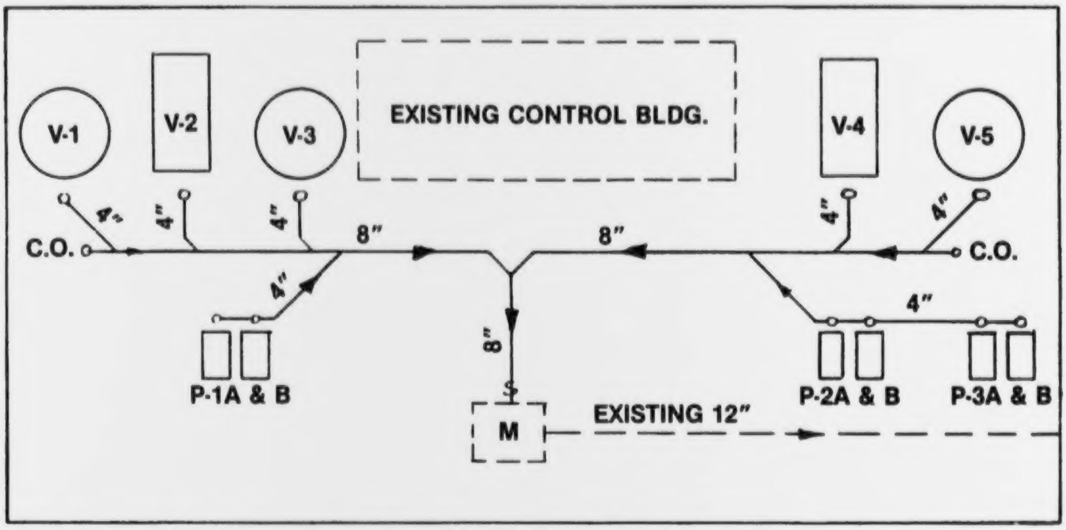

LITE POST SIGN
CHADMAN CB
STREET LITE
6" GAS
24" ST SEW
ASPHALT OVER CONC
100'
12" ST SEW
2" HICKORY
29'
4' WIRE FENCE
ASPHALT DR
4' WIRE FENCE
IRON
GRAVEL PARKING AREA
50'
16" G.I.W. with 6"x16" W.M. EAST, CAP & THRUST
CB
CONC INL
GAS STA
STORE
6" GAS
12'
TELEPHONE
ELECTRIC SIGN
ASPHALT
2'x4' CONC. SLAB
PLANTER
SIGN
BLDG
ASPHALT IN BAD CONDITION
I POLE
(SOUTHBOUND LANES)
CONC ISLAND
(ASPHALT OVER CONC)
TELEGRAPH RD
(NORTHBOUND LANES)
CB
CONCRETE
STL POLE
CONC DR
16" G.I.W. 91+96 91+99
16" W.M. @ 0.007%
END 92+02 92+05 PLUGGED & THRUSTEED
102'
685.0 91+00
685.0 91+96
91+00
93+00
94+00

Typical Flow Diagram

(Sewer Layout)

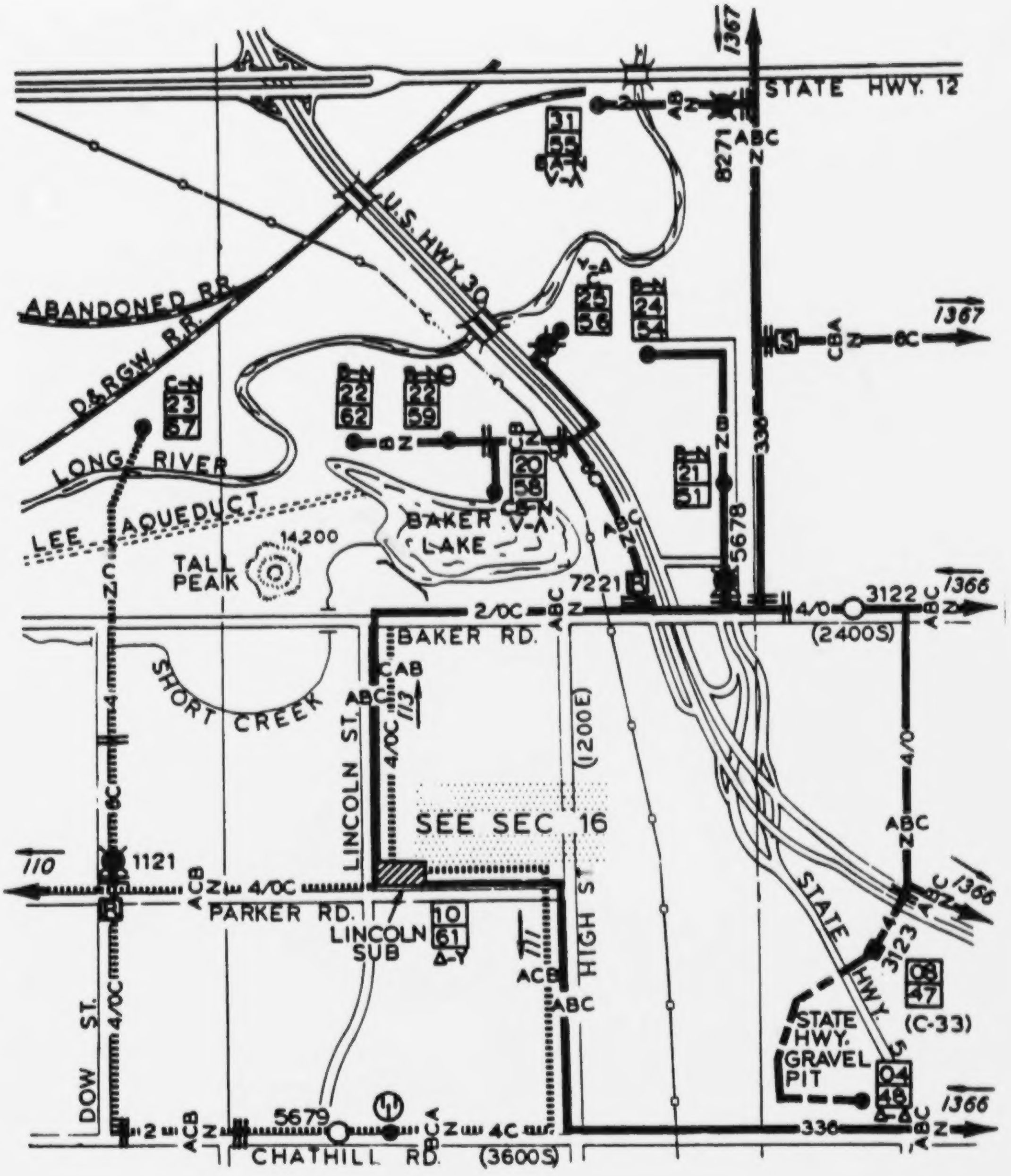
Sewer Flow Diagram Symbols and Abbreviations

V	**Vessel**
P	**Pump**
T	**Tank**
M	**Manhole**
CB	**Catch Basin**
o—	**Drain Funnel**
o-ɸ-	**Drain Funnel with Seal or Running Trap**
►—S—[M]	**Manhole with Sealed Inlet**
◄—S—[CB]	**Catch Basin with Sealed Outlet**
◄——CO	**Cleanout**


V-1
V-2
V-3
EXISTING CONTROL BLDG.
V-4
V-5
C.O.
4"
4"
4"
8"
8"
4"
4"
C.O.
4"
4"
8"
P-1A & B
M
EXISTING 12"
P-2A & B
P-3A & B

Typical Distribution Map

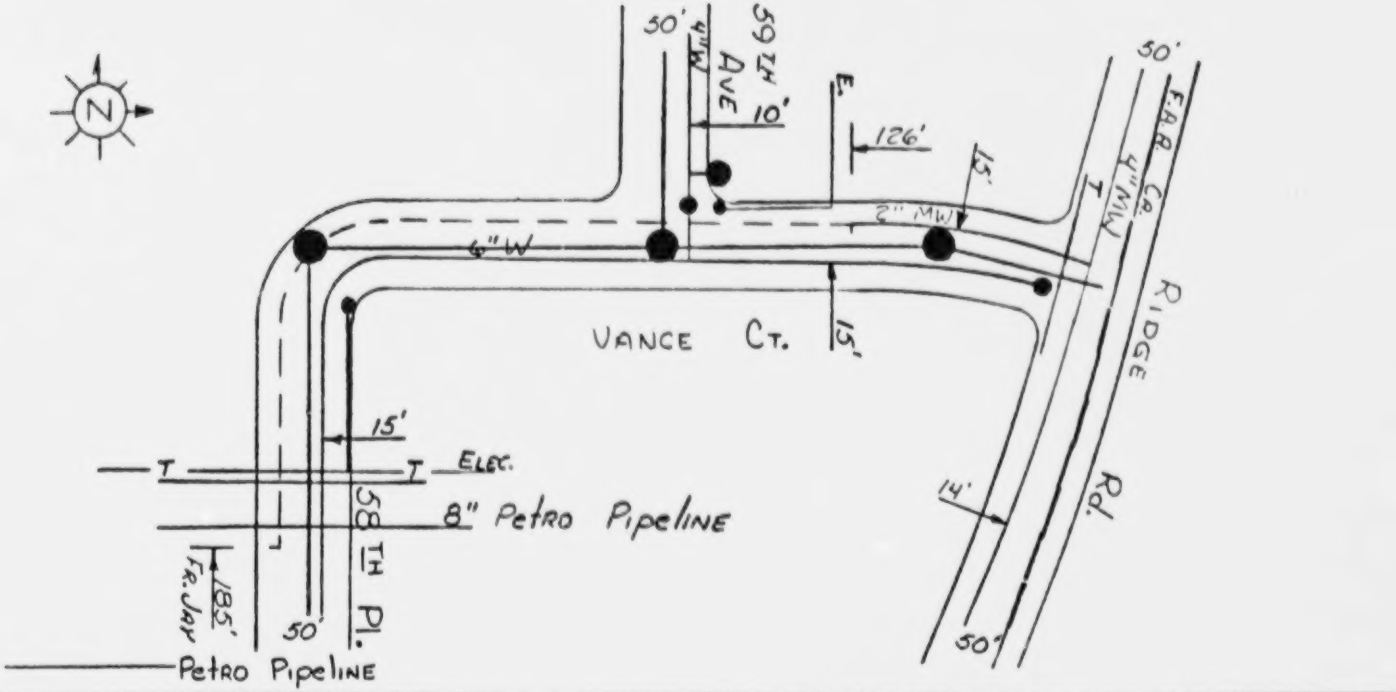
(Electric)


1367
STATE HWY. 12
8271
ABC
U.S. HWY. 30
ABANDONED R.R.
D&RGW R.R.
1367
LONG RIVER
LEE AQUEDUCT
BAKER LAKE
TALL PEAK
14,200
5678
330
7221
2/0C
4/0
3122
(2400S)
1366
BAKER RD.
SHORT CREEK
LINCOLN ST.
4/0C
113
SEE SEC 16
HIGH ST.
(1200E)
110
1121
4/0C
PARKER RD.
LINCOLN SUB
111
1366
3123
STATE HWY.
(C-33)
STATE HWY. GRAVEL PIT
DOW ST.
8C
5679
4C
330
1366
CHATHILL RD.
(3600S)

Courtesy of Public Service Company of Oklahoma.

Typical Obstruction Map

(and Proposed Gas Sketch)


N
50'
4"W
59TH AVE
10'
E
126'
15'
2" MW
50'
F.A.A. CA.
4" MW
T
6"W
RIDGE
VANCE CT.
15'
15'
T
T
ELEC.
8" Petro Pipeline
58TH Pl.
Rd.
14'
185'
Fr. Jay
50'
50'
Petro Pipeline

LEGEND

Present Gas ———————
Proposed Gas — — —
Range Lines ——— BROWN
Water Phone ——— RED
Sewer Phone ——— ORANGE
Telephone Phone ——— GREEN
Electric Phone ——— PURPLE
Steam Phone ——— Blue & Yellow (Alt)
Western Union Phone ——— Yellow/Black Edges
Pipe Protection

SYSTEM INFORMATION

Max Press.
I.P. Press. Test
Cell Cont. Equip.
Tie-in

Area Reg. Sta.
Press. System
Cont. Area
Wild Boost
Elec. Outage

DATE	DRAWN BY	ORDER NO.

Typical Utility Easement Layout

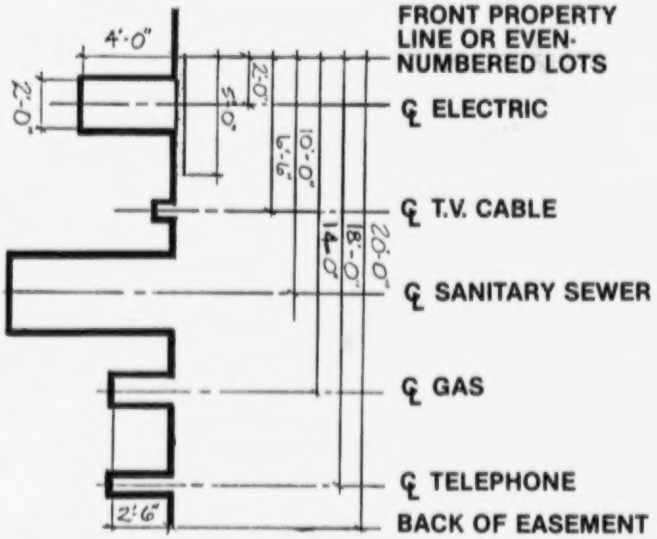
A. The electric will be located in the easement 2' from the front property line. ATA depth of 4'-0".

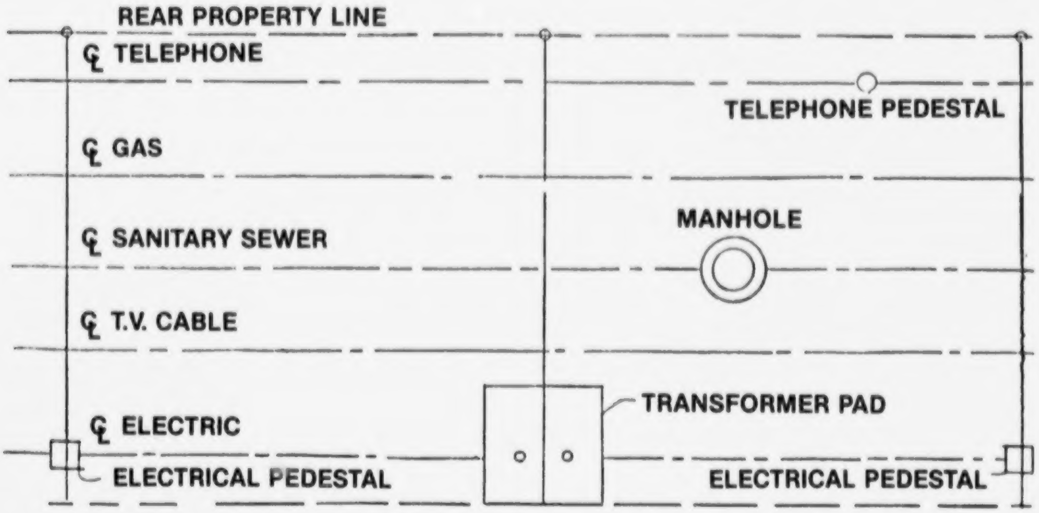
B. The telephone facilities will be located in a trench 18'-0" from the front property line at a depth of 30".

C. The sanitary sewer will be located in the easement 10' from the front property line.

D. The gas will be located in the easement 14'-0" from the front property line.

E. T.V. cable located 6'-6" from front property line.


FRONT PROPERTY LINE OR EVEN-NUMBERED LOTS
4'-0"
2'-0"
2'-0"
5'-0"
6'-6"
10'-0"
14'-0"
18'-0"
20'-0"
℄ ELECTRIC
℄ T.V. CABLE
℄ SANITARY SEWER
℄ GAS
℄ TELEPHONE
2'-6"
BACK OF EASEMENT


REAR PROPERTY LINE
℄ TELEPHONE
TELEPHONE PEDESTAL
℄ GAS
MANHOLE
℄ SANITARY SEWER
℄ T.V. CABLE
TRANSFORMER PAD
℄ ELECTRIC
ELECTRICAL PEDESTAL
ELECTRICAL PEDESTAL

MUNICIPAL MAPPING
UNIT X

ASSIGNMENT SHEET #1 — RESEARCH THE PLATS FOR LOCAL UTILITIES

Directions:

1. Locate the address and phone number of each of the following utilities in your area:
    a. Gas
    b. Electric
    c. Water
    d. Sewer
    e. Telephone
2. Contact each one by phone or letter to find out how you can obtain a copy of the plat that shows the utilities into your address.
3. Obtain copies of these plats through visitation of the utility or through the mail. Also request a copy of the symbols each utility uses for your future reference.

MUNICIPAL MAPPING
UNIT X

ASSIGNMENT SHEET #2 — DRAFT A MAP OF ALL UTILITIES FOR A LOCAL AREA

Given: The copy of the plats for all the utilities for your address (after completion of Assignment Sheet #1).

Directions:

1. You will be using the plat maps of the utilities for your area as resource information.
2. Set up your base map. Determine the map scale with your instructor.
3. Set up overlay maps for each separate utility. Either trace from original plats if scale corresponds or repost information. Use the same symbols that the utility company provides.
4. Compile a legend on each overlay for the symbols used.
5. Ink on polyester film.

MUNICIPAL MAPPING
UNIT X

NAME ____________________

TEST

1. Match the terms on the right with the correct definitions.

_____a. Drawing that shows a system in a symbolic manner as opposed to conventional mapping format

_____b. A map that shows the location of all plats and plat numbers

_____c. The recordation of public utilities such as gas, electric, water, and sewer lines onto a map for public record

_____d. A map that shows roads, highways, ditches, rivers, lakes, and subdivisions

_____e. A map that contains one line configurations of all overhead and underground primary and secondary utility lines

1. Base map
2. Distribution map
3. Flow diagram
4. Index map
5. Municipal mapping

2. List five types of utilities.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

3. List four agencies who develop and maintain municipal maps.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

TEST

4. List five users of municipal maps.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

5. Select from the following list the types of drawings used in municipal mapping by placing an "X" in the appropriate blanks.

_____a. Obstruction maps

_____b. Geological maps

_____c. Aeronautical maps

_____d. Plat maps

_____e. Index maps

_____f. Distribution maps

_____g. Flow diagrams

_____h. Profile

_____i. Plan

_____j. Cross sections

_____k. Base maps

_____l. Bill of materials (quantity sheets)

6. List two methods of presenting utilities on maps.

a. ______________________________

b. ______________________________

TEST

7. Select true statements concerning the surveying and mapping of municipal maps by placing an "X" next to the true statements.

   _____a. Horizontal control monuments established by triangulation and traverse are of third class order accuracy.

   _____b. Vertical control benchmarks are established by differential levels.

   _____c. Base maps are compiled to provide a common basis for topographic maps, property maps, subdivision maps, and maps showing the position of utility lines.

   _____d. Scales of base maps are always 1" = 50'.

   _____e. Base maps will include the state plane coordinates.

   _____f. Base maps are generally laid out in ¼ section showing all streets, highways, railroads, etc.

8. List five types of support information needed to develop utility drawings for a specific area.

   a. ____

   b. ____

   c. ____

   d. ____

   e. ____

9. Complete the following statements concerning utility easements by circling the correct words.

   a. Utility easements are usually shown on the (**plan and profile, subdivision plat**) to indicate the location of any and all utilities.

   b. Generally each utility will be located in a standard location with reference to the (**front, back, side**) property line(s).

TEST

10. Match types of valves and valve housings on the right with the correct definitions.

_____a. Used to protect equipment and workers from sudden and dangerous excess pressures

_____b. Used for flow regulation, throttling, and frequent operation

_____c. Used for quick start-stop operations; has a ball to stop flow through valve

_____d. Used to automatically maintain accurate, constant, and uniform flow in a line

_____e. An underground structure designed to house a valve 8" and larger or a series of valves

_____f. Used for infrequent start-stop operations; has a disk to stop flow through valve

_____g. Used to prevent backflow; available as swing or lift for different applications

_____h. A small structure designed to house a valve up to and including 6"

_____i. Used for quick start-stop operations; has a slotted core or plug that stops flow when turned 90°

1. Ball valve
2. Check valve
3. Gate valve
4. Globe valve
5. Plug valve
6. Pressure regulator valve
7. Pressure safety valve
8. Valve box
9. Valve vault

TEST

11. Match types of gas piping and devices on the right with the correct definitions.

______a. An opening at the top of a valve vault making housed valves accessible at all times

______b. Distance between top of pipe and street surface

______c. Equipment designed to reduce and control gas pressure manually, automatically, or by remote control

______d. A small pipe, usually ¾" or 1¼", used in connection with a regulator station to control pressure rather than to transport gas

______e. Same as casing, but carrier is insulated from pipe with insulated spacers and bushings

______f. Gas piping installed in a vertical position, usually exposed and fastened to building walls, poles, or other rigid structures

______g. A wooden post 8′ in length with metal warning signs on two sides in line with the pipeline installed directly over the main where measurements from a permanent object or source are not available

______h. That portion of pipe used for transporting low pressure gas from the main to the meter

______i. Pipe sleeve generally used for railroad, highway, ditch, and bridge crossings to enclose the main in a protective casing

______j. Power or telephone line usually set 1 foot on road side of property line

______k. A short piece of pipe

______l. Distance to end of main from a stationary point such as property line, pole line, etc.

______m. A portion of piping vertical to the ground used for the installation of an outside meter

______n. A device designed to reduce gas pressure and maintain constant pressure for customer's use; located between the service terminal valve and the gas meter

______o. A device for measuring customer gas usage in cubic feet

1. Casing
2. Casing, insulated
3. Control line
4. Cover
5. Main ending
6. Manhole
7. Marker, pipe line
8. Meter
9. Meter riser
10. Nipple
11. Pole line
12. Regulator station
13. Riser
14. Service, low pressure
15. Service regulator

TEST

12. List five types of information included on utility drawings.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

13. Match types of sewers and sewer lines on the right with the correct descriptions.

_____a. Collects rain wash and fire water

_____b. Collects water from drains of equipment, drips from pumps, and other dirty drains

_____c. Collects both storm and process sewers utilizing only one piping system

_____d. Carries human wastes

_____e. Liquid collection point that usually projects about 2" above the finished grade

_____f. Lines (4" minimum) that collect from various drain funnels or catch basins and tie to sublaterals

_____g. Sewer lines collecting from two or more sublaterals and discharging to mains through a sealed manhole

_____h. Lines that collect flow from two or more laterals and are usually located in roadway easements; are sealed at regular intervals with manholes to prevent the spread of fire or gas backup

_____i. Openings located at the ends of branches and long line runs which allow the sewer to be cleaned by removing a plug and inserting a long flexible steel bar

1. Branches
2. Cleanouts
3. Combined sewer
4. Funnel
5. Laterals
6. Process sewer
7. Sanitary sewer
8. Sewer mains
9. Storm sewer

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

14. Research the plats for local utilities. (Assignment Sheet #1)

15. Draft a map of all utilities for a local area. (Assignment Sheet #2)

MUNICIPAL MAPPING
UNIT X

ANSWERS TO TEST

1.
   a. 3
   b. 4
   c. 5
   d. 1
   e. 2

2. Any five of the following:
   a. Gas
   b. Electric
   c. Water
   d. Sewer
   e. Telephone
   f. Cable for television
   g. Drainage

3. Any four of the following:
   a. Public service companies
   b. Rural power companies
   c. Department of public works
   d. Department of waste management
   e. Telephone company
   f. Water department

4. Any five of the following:
   a. Architects
   b. Land developers
   c. City planners
   d. Telephone company
   e. Builders
   f. Zoning department
   g. Individuals
   h. Engineers
   i. Surveyors

5. a, d, e, f, g, h, i, k, l

6. Any two of the following:
   a. Separate maps for each utility
   b. Base map with overlays to show the location of each utility
   c. Composite maps
   d. CAD — Each utility can be stored on a separate layer in the computer

7. b, c, e, f

ANSWERS TO TEST

8. Any five of the following:
   a. Adjacent plats
   b. Miscellaneous information on subs, ordinances, and deed pertaining to plat to be drawn
   c. Aerial photos
   d. Railroad maps
   e. Highway maps
   f. U.S.G.S. maps
   g. Easement file
   h. Transmission pipeline plats
   i. Obstruction maps
   j. Electric transmission right-of-ways

9. a. Subdivision plat
   b. Front

10.

a.	7	f.	3
b.	4	g.	2
c.	1	h.	8
d.	6	i.	5
e.	9		

11.

a.	6	i.	1
b.	4	j.	11
c.	12	k.	10
d.	3	l.	5
e.	2	m.	9
f.	13	n.	15
g.	7	o.	8
h.	14		

12. Any five of the following:
   a. Easement dimensions
   b. Symbols and labels
   c. Bill of materials
   d. Schematic symbols for fittings, valves, sewer lines, water lines, and taps
   e. Manhole locations
   f. Distance of gas main, sewer line, or water tap from property line
   g. Sizes and types of valves and lines
   h. Locations of obstructions
   i. Existing and proposed utility lines
   j. Underground cables
   k. Street lighting symbols (depending on type of drawing)

13.

a.	9	f.	1
b.	6	g.	5
c.	3	h.	8
d.	7	i.	2
e.	4		

14.-15. Evaluated to the satisfaction of the instructor

STRUCTURAL DRAFTING
UNIT XI

UNIT OBJECTIVE

After completion of this unit, the student should be able to prepare detail drawings of structural steel members, draw to scale a concrete engineering drawing, and detail a wood truss. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to structural drafting with the correct definitions.
2. Define structural drawing.
3. List types of structures.
4. List three types of materials used for structures.
5. Match types of steel members with the correct characteristics and descriptions.
6. Identify structural steel shapes.
7. Select true statements about drawing practices for steel members.
8. Describe the placement of gage lines for steel members.
9. Complete statements concerning fastener sizes and spacings.
10. Complete statements concerning dimensioning procedures for steel structures.
11. Label a structural steel callout.

OBJECTIVE SHEET

12. Select true statements concerning structural steel marking.

13. Complete statements concerning anchor bolts.

14. Distinguish between the types of concrete.

15. Complete statements concerning the types of concrete reinforcement.

16. Identify standard prestressed concrete units.

17. Match foundation parts with the corrrect descriptions.

18. Match types of structural drawings for concrete with the correct descriptions.

19. Complete a chart of standard symbols and abbreviations for concrete placing drawings.

20. Select true statements concerning standard practices for documentation of rebar.

21. Identify examples of typical details for conctete structures.

22. Complete statements concerning wood construction.

23. Identify types of wood connectors.

24. Identify types of framing connectors.

25. Select true statements concerning components of wood construction.

26. Complete statements concerning heavy timber construction.

27. Prepare detail drawings of structural steel members. (Assignment Sheet #1)

28. Draw to scale a concrete engineering drawing. (Assignment Sheet #2)

29. Detail a wood truss. (Assignment Sheet #3)

STRUCTURAL DRAFTING
UNIT XI

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

1. American Institute of Steel Construction (AISC)
   7730 Carondelet Avenue
   St. Louis, MO 63105
   314/721-1332

2. American Concrete Institute (ACI)
   P.O. Box 19150
   Detroit, MI 48219

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Visit a construction site and observe the various methods of construction for wood, steel, and concrete.
2. Review MAVCC books on architectural and light construction for standards on light frame construction.
3. Provide examples of actual structural details and engineering drawings used in structural drafting.
4. Take a field trip to a large civil engineering firm to see how the structural drafter fits in with civil drafting.
5. Provide copies of the AISC and ACI manuals for use in the assignment sheets.
6. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1 — Structural Steel Shapes
2. TM 2 — Gage Line Standards
3. TM 3 — Dimensioning Procedures for Structural Steel
4. TM 4 — Dimensioning Procedures for Structural Steel (Continued)
5. TM 5 — Dimensioning Procedures for Structural Steel (Continued)
6. TM 6 — Dimensioning Procedures for Structural Steel (Continued)
7. TM 7 — Dimensioning Beam Channels
8. TM 8 — Rebar Data
9. TM 9 — Standard Prestress Concrete Units
10. TM 10 — Examples of Foundation Parts
11. TM 11 — Examples of Foundation Parts (Continued)
12. TM 12 — Examples of Foundation Parts (Continued)
13. TM 13 — Typical Bar List
14. TM 14 — Common Wood Connectors
15. TM 15 — Framing Connectors
16. TM 16 — Framing Connectors (Continued)
17. TM 17 — Heavy Timber Construction
18. TM 18 — Heavy Timber Construction (Continued)

D. Assignment sheets

1. Assignment Sheet #1 — Prepare Detail Drawings of Structural Steel Members
2. Assignment Sheet #2 — Draw to Scale a Concrete Engineering Drawing
3. Assignment Sheet #3 — Detail a Wood Truss

E. Answers to assignment sheets

F. Test

G Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. Hoelscher, Randolph, Clifford Springer, and Jerry Dobrovolny. *Graphics for Engineers.* New York: John Wiley and Sons, Inc., 1968.

B. *Drafting Manual.* Public Service Company of Oklahoma, Tulsa, Oklahoma, 1968.

C. Weaver, Rip. *Structural Drafting.* Houston, TX: Gulf Publishing Co., 1977.

D. Bishop, Carlton. *Structural Drafting.* New York, NY: John Wiley & Sons, 1941.

E. Huntington, Whitney Clark. *Building Construction.* New York, NY: John Wiley & Sons, 1963.

F. Alpine Truss *Architectural Engineering Manual.* Pompano Beach, Florida, 1980.

G. *Encyclopedia of Trusses.* St. Louis, MO: Lumbermate Co., 1983.

H. Jensen/Helsel. *Engineering Drawing and Design.* New York: McGraw-Hill Book Co., 1985.

I. American Institute of Steel Construction
400 North Michigan Avenue
Chicago, Illinois 60611

1. *Manual of Steel Construction*, USA, © 1980
2. *Structural Steel Detailing*, © 1966
3. *Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings*

J. American Concrete Institute
P.O. Box 19150
Detroit, MI 48219

1. *Detailing Manual*, Publication SP-66, © 1980
2. *Building Code Requirements for Reinforced Concrete*
3. *Recommended Practice and Standard Specifications for Concrete and Reinforced Concrete*

K. *Timber Construction Manual.* American Institute of Timber Construction (AITC), 333 W. Hampton Avenue, Englewood, CO 8010.

L. *Typical Designs of Timber Structures.* Timber Eng. Co., Washington, D.C.

M. *Heavy Timber Construction Details*, National Lumber Manufacturers Association, Washington, D.C.

N. Weaver, Gerald. *Structural Detailing.* New York: McGraw-Hill Book Co., 1974.

O. Truss Plate Institute (TPI)
100 West Church Street
Frederick, MD 21701

STRUCTURAL DRAFTING
UNIT XI

INFORMATION SHEET

I. **Terms and definitions**

A. Bay — The space between two consecutive sets or tiers of columns and beams, or columns and trusses

B. Bent — A vertical framework, usually columns and beams supporting other members

C. Bottom chord — The main member of a truss running along its lower side between supports and usually carrying tension and bending

D. Chord — The top or bottom members of a truss

E. Clear span — That horizontal measurement between the inside faces of the two bearings or supports

F. Column — A vertical compression member, usually supporting beams and girders

G. Compression — A force caused by loads being placed on a member that causes a squeezing or shortening effect on the member

H. Concrete (as defined by the American Concrete Institute [ACE]) — A mixture of portland cement, fine aggregate, coarse aggregate, and water

I. Cope — To cut out a part of the top or bottom flange of a beam or channel so that it may fit another

J. Flange — The top and bottom projection or outstanding parts of a beam, channel, or girder

K. Gage line — The line along which fastener holes are punched or drilled in structural members

L. Girder — A member designed to carry bending stress, usually supporting other members

M. Grout — A fluid mixture of cement, water, and sand which can be poured to fill small voids or to smooth or level a surface of a wall or footing

N. Gusset plate — A plate connecting the several members of a truss or other structural framework

O. Lintel — A structural member designed to carry the wall over a window, door, or other opening

P. Nominal span — Horizontal distance between the outside edges of supports

INFORMATION SHEET

Q. Panel — The space between two purlins in a roof or between two vertical members in a bridge truss

R. Prestressed concrete — Concrete that is precast or cast in place that has wires or cables that are stretched before the concrete is placed around them; the releasing of the wires or cables sets up internal stresses that counteract the external stresses of the applied load to prevent cracking and sagging

S. Purlin — The horizontal members spanning from truss to truss, upon which the roof is carried

T. Rafter — The wood members used to support the roof in conventional framing

U. Rebar — A round, square, or deformed bar used to reinforce concrete

V. Smooth bar — A bar used in slip joints for expansion joints

W. Steel member — A unit part of some larger structure

Example: Floor beam or post in a steel bridge

X. Stress — A unit of force working within a member expressed in pounds per square inch (PSI)

Y. Top chord — Main member of a truss running along its upper side supporting the decking and usually carrying combined compression and bending

Z. Truss — A steel or timber framework whose members take only tension or compression stresses

AA. Web — The portion of an I-beam, channel, or girder between the upper and lower flanges

BB. Working line — The line where locating dimensions are given

CC. Working point (WP) — The edge point where dimensions are given

II. **Structural drawing** — All layout and detail drawings connected with the design and construction of buildings, bridges, viaducts, and similar structures in which structural steel, timber, concrete, and other building materials are used

III. **Types of structures**

A. Buildings

B. Bridges

C. Dams

D. Reinforced concrete foundations

INFORMATION SHEET

E. Manholes

F. Box culverts

G. Retaining walls

IV. Types of materials used for structures

A. Steel

B. Concrete

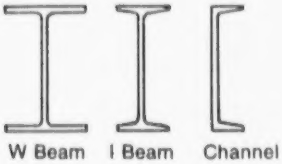
C. Timber

V. Types of steel members

A. Beams

1. Generally are composed of a single piece.
2. Generally are placed horizontally and are subjected to vertical loads.
3. Steel beams are standardized.
    a. Wide flange (W) beams
    b. "I" beams
    c. Channel (C)

    Example:



4. The length of a beam is the extreme dimension as shipped.

    (NOTE: When the connection angles are used at both ends, the length is the distance from back to back of angles.)

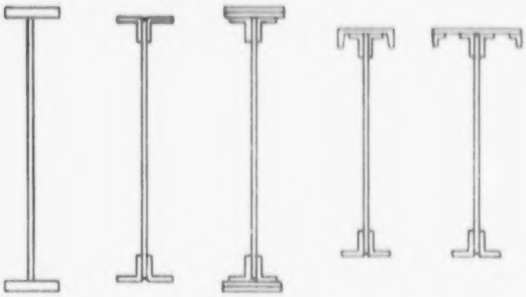
B. Girders

1. Are beams made of more than one piece.

INFORMATION SHEET

2. Are members usually made with a web plate and flanges composed of angles, plates, or both, used to resist bending due to transverse loads.

   Example:



C. Columns — Form the principal supports of all steel structures other than bridges and similar spans which rest directly upon masonry and concrete.

D. Roof trusses

1. Roof trusses are used wherever a comparatively large area is to be covered without intermediate columns.

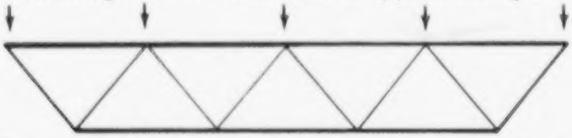
2. The web members of an ordinary roof truss are made of single or double angles with the longer legs vertical.

3. Usually riveted or welded in the shop completely or in as large of sections as can be shipped.

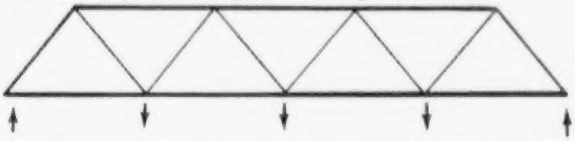
4. Different members of a truss are connected by means of a gusset plate.

E. Bridge trusses

1. Deck bridge — The floor load is applied along the upper chord.



2. Through bridge — The floor load is applied along the lower chord, and traffic flows through the bridge trusses.



3. The joints of a bridge truss may be riveted, welded, or pin connected.

INFORMATION SHEET

VI. **Structural steel shapes** (Transparency 1)

  A. American standard beam (S): I-beam — Used for beams and struts

  B. American standard channels (C)

    1. Used for struts and in trusses when light loads are required

    2. Used for steel platforming as load bearing members

  C. Wide flange shapes (W) — Used for beams and columns

  D. Structural tees (WT and ST) — Made by splitting S and W shapes

  E. Angles (L) — Used for struts, platforms, cross bracing in trusses, and to add framing strength

  (NOTE: Legs of angles may be equal or unequal.)

  F. Flat bars (bar) — Have a rectangular cross section and are standardly limited to 6" or 8" widths

  G. Plate (PL or ⅊) — Rectangular in cross section; larger than bars. Plate widths start at 10" and are rolled up to 200" widths depending on thickness. Lengths are as long as shipping will allow.

  H. Floor plate (Floor PL or Floor ⅊) — A skid resistant raised pattern on one side used for a walking surface

  (NOTE: A full listing of shape designations can be found in the AISC *Manual of Steel Construction*.)

VII. **Drawing practices for steel members**

  A. Typical drawing scale

    1. 3/8" = 1'0" — If overall dimensions can be shown on one drawing

    2. 1/4" = 1'0" — Used for large structures (framing and erection plans)

    3. No Scale — Used for most detail drawings except:

      a. 3" = 1'0" — Details of joints

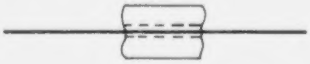
      b. 1" or 1 1/2" = 1'0" — Details of trusses

INFORMATION SHEET

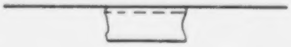
B. Drawing convention

(NOTE: The drafter works from design layouts or framing plans prepared by architects or designers which show the arrangement of columns, girders, and beams. The detailer prepares a framing or erection layout which may show a plan view, elevation, or both identifying all members with a piece mark. Connections may be ommitted and shown as assembly in trusses, columns, beams, and braces.)

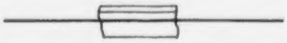
1. Single line drawing — Used when the scale doesn't allow for a lot of detail.
    a. Steel members are represented by a heavy line.
    b. Along the heavy line a double line of the steel member will be placed to clarify angle or flange orientation.
2. Single line in plan view represents
    a. Centerline of beam



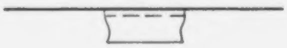
    b. Back of channel



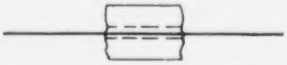
    c. Work line of angle bracing



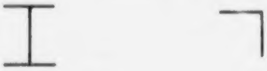
    d. Back of angle when used as a beam



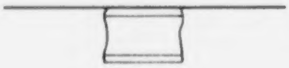
    e. Centerline of structural tee



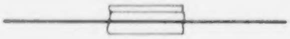
    f. Column end view



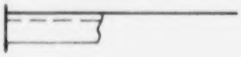
3. Single line in elevation view represents
    a. Top of beam and channel



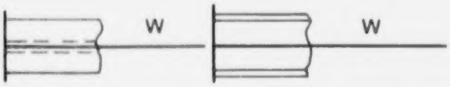
    b. Work line of angle or structural tee bracing



    c. Back of angle when used as beam or column



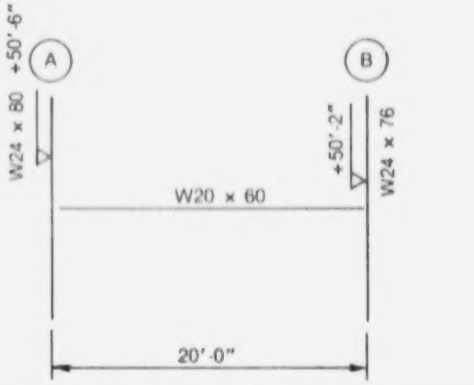
    d. Centerline of wide flange column



INFORMATION SHEET

4. Design drawing

Example:



ELEVATION TOP OF STEEL SHOWN THUS (+50'-6")

NOTES:
ALL HOLES ϕ $^{13}/_{16}$
ALL CONNECTIONS TO DEVELOP FULL LENGTH
UNLESS OTHERWISE SPECIFIED
BOLTS: $^{3}/_{4}$ A325
CONNECTING ANGLES WELDED TO BEAM,
BOLTED TO SUPPORT

a. Gives the structural detailer information to set up complete detail drawings.

   1) Length

   2) Size and type

   3) Number and type of fasteners

b. Describes the type of construction and end loads.

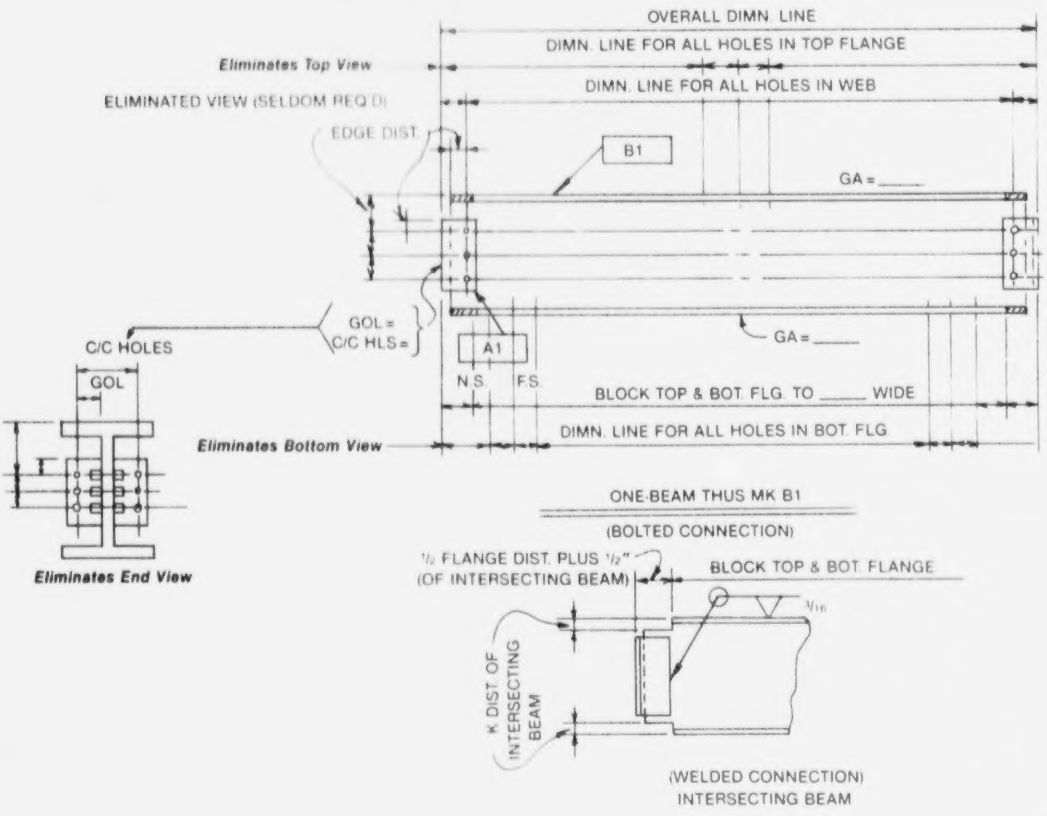
c. Members on design drawings are presumed to be parallel or at right angles to one another.

d. Elevation view dimensions of beams are generally given as notes on drawings prepared by the designer/architect.

INFORMATION SHEET

5. Because of industry concern about improving productivity of detailers, a method of special dimensioning practices and notation has been devised to eliminate otherwise necessary views. Examine the following examples describing these techniques.

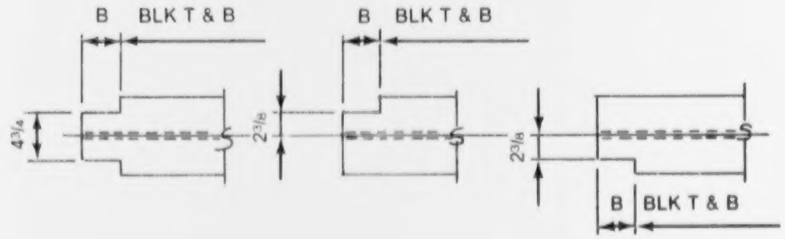
Example 1: Beam dimensioning and notation


OVERALL DIMN. LINE
DIMN. LINE FOR ALL HOLES IN TOP FLANGE
Eliminates Top View
DIMN. LINE FOR ALL HOLES IN WEB
ELIMINATED VIEW (SELDOM REQ'D)
EDGE DIST.
B1
GA = ____
GA = ____
GOL =
C/C HLS =
C/C HOLES
GOL
A1
N.S.
F.S.
BLOCK TOP & BOT. FLG. TO ____ WIDE
DIMN. LINE FOR ALL HOLES IN BOT. FLG.
Eliminates Bottom View
Eliminates End View
ONE-BEAM THUS MK B1
(BOLTED CONNECTION)
½ FLANGE DIST. PLUS ½"
(OF INTERSECTING BEAM)
BLOCK TOP & BOT. FLANGE
5/16
K DIST. OF INTERSECTING BEAM
(WELDED CONNECTION)
INTERSECTING BEAM

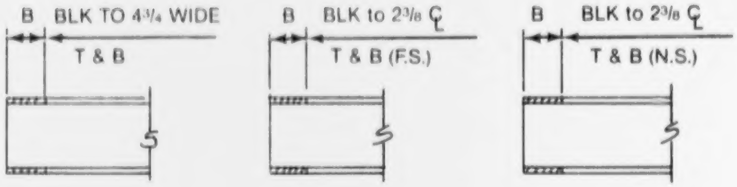
NS = Near side gauge line
FS = Far side gauge line
C/C HLS = Center to center holes
GOL = Gauge outside leg

INFORMATION SHEET

Example 2: Blocking (coping) of beams


B
BLK T & B
4 3/4
2 3/8
B
BLK T & B
2 3/8
B
BLK T & B

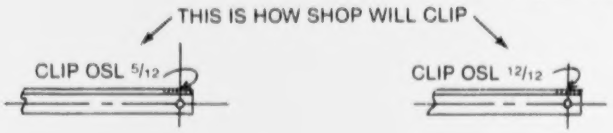
WHEN FLANGE VIEW IS SHOWN


B
BLK TO 4 3/4 WIDE
T & B
B
BLK to 2 3/8 ℄
T & B (F.S.)
B
BLK to 2 3/8 ℄
T & B (N.S.)

WHEN WEB VIEW IS SHOWN

Example 3: Clipping of angles

Only View Required with Notation


THIS IS HOW SHOP WILL CLIP
CLIP OSL 5/12
CLIP OSL 12/12

CLIP AND BACKSUT ANGLES ONLY WHEN REQUIRED USING 5 TO 12 OR 12 TO 12 BEVELS. HOLD OTHER BEVELS TO A MINIMUM.

6. Symmetrical members
   a. Large members such as trusses and plate girders are symmetrical about a centerline and only one half is detailed.
   b. It is standard to detail the left half.
   c. The detail should be broken past the centerline by a ragged or wavy line.

INFORMATION SHEET

7. Standard details

    a. Many steel details have become standardized and the drafter should become familiar with and adhere to these. Standards specifications can be found in the *AISC Steel Construction Manual*.

    b. Many firms have printed forms showing required views of a beam and it is only necessary for the drafter to fill in the dimensions.

VIII. **Placement of gage lines** (Transparency 2) — The lines along which fastener holes should be placed in the flanges of I-beams, channels, and angles are standardized.

A. Angles — Gage line is measured from the back of the angle.

B. Flanges of channels — Gage line is measured from the back of the channel.

C. Flanges of I-beams — Gage line is measured from the center.

D. Standard gages for I-beams, channels, and angles are located in the *AISC Steel Construction Manual*.

IX. **Fastener sizes and spacings**

A. Minimum distance for fastener spacing along the gage line has been established by the AISC.

B. The minimum fastener size is governed by the following rule: The diameter of the fastener should never be less than the thickness of the metal punched.

X. **Dimensioning procedures for steel** (Transparencies 3-7)

A. Use aligned method for locating dimensions.

B. Dimensions are in feet and inches and should be placed on top of the dimension line.

C. Longest and overall dimension should be farthest away from the view.

D. The detail dimensions should always be added to see if they check with the overall dimension.

E. Dimensions should be placed no closer than 5/16" apart and the first line should be no closer than double this distance.

F. Dimensions should be given to centerline of beams and backs of angles and channels.

INFORMATION SHEET

G. Dimensions should be given to the top or bottom of beams and channels, never to both top and bottom.

H. Where a dimension line runs through a hole whose location it does not give, the dimension line should be broken and an arc drawn around the hole.

I. If a particular dimension is for attachment to a column, beam, or equipment to be mounted on the structure, a notation "HOLD" should be indicated next to the dimension.

J. When four or more equal spaces between bolts are required, a note is used such as 4 @ 2 = 8.

K. Elevation detail dimensions known as levels are usually given as notes on the drawing.

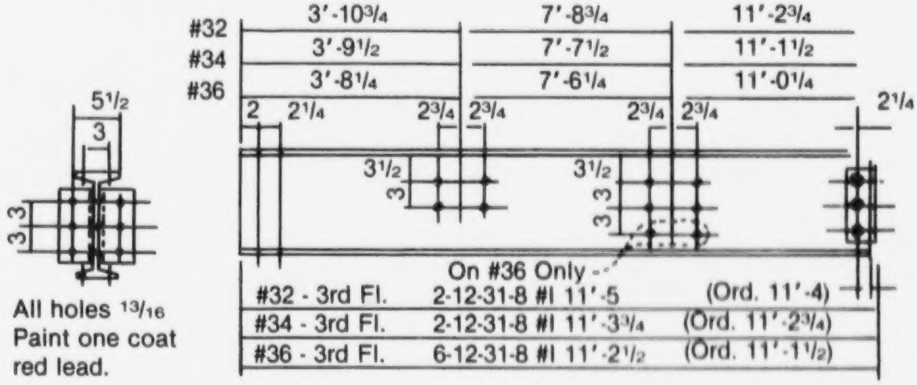
   1. A reference point is established in the structure, usually top of concrete floor or foundation.

   2. Elevations above this point are plus values.

   3. Elevations below this point are minus values.

L. When beams are of the same size and vary only in length, the same drawing can be used for several beams. A set of dimensions for each beam are shown.

Example:


#32
#34
#36
3′-10¾
3′-9½
3′-8¼
7′-8¾
7′-7½
7′-6¼
11′-2¾
11′-1½
11′-0¼
2
2¼
2¾
2¾
2¾
2¾
2¼
5½
3
3½
3
3½
3
3
3
3
On #36 Only
#32 - 3rd Fl. 2-12-31-8 #I 11′-5 (Ord. 11′-4)
#34 - 3rd Fl. 2-12-31-8 #I 11′-3¾ (Ord. 11′-2¾)
#36 - 3rd Fl. 6-12-31-8 #I 11′-2½ (Ord. 11′-1½)
All holes 13/16
Paint one coat
red lead.

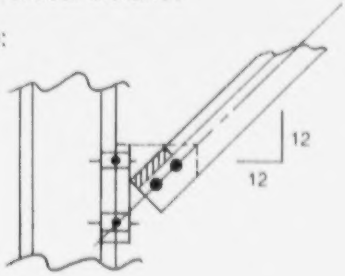
M. The slope of all members should be given in rise and run, not angles.

   1. Run — Horizontal distance

INFORMATION SHEET

2. Rise — Vertical distance

   Example:



N. End distances and edge distances are usually given by note on light truss members and dimensioned on beams, columns, and girders.

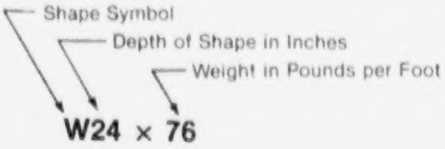
O. Gage lines should be dimensioned even though they are standard.

P. When lengths of fasteners vary, the various lengths and quantities should be shown at connections on the erection plan, or in a reference list.

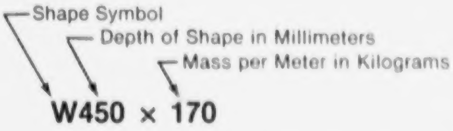
Q. On truss members, detail dimensions should be placed in a continuous row from end to end of the member with no dimension being omitted.

XI. Structural steel callouts

A. Inch designation


Shape Symbol
Depth of Shape in Inches
Weight in Pounds per Foot
W24 × 76

B. Metric designation


Shape Symbol
Depth of Shape in Millimeters
Mass per Meter in Kilograms
W450 × 170

XII. Structural steel marking

A. Marks are used to provide a systematic procedure for detailing, fabricating, and erection.

B. Each member of a structure is given a mark on the design layout.

C. Mark is painted on the piece and used to erect the structure in the field.

D. Each company has its own system of marking.

E. For more information on marking systems, refer to AISC *Structural Steel Detailing*.

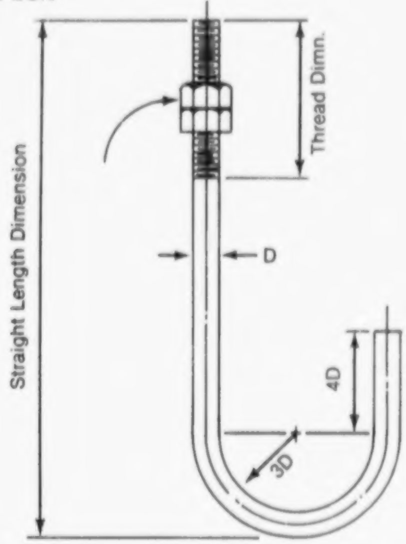
INFORMATION SHEET

XIII. Anchor bolts

A. Used for anchoring equipment such as pumps, steel structures, and compressors to concrete foundations.

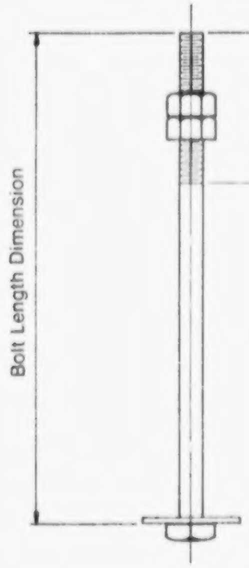
B. Types of anchor bolts

1. J-bolt


Thread Dimn.
Straight Length Dimension
D
4D
3D

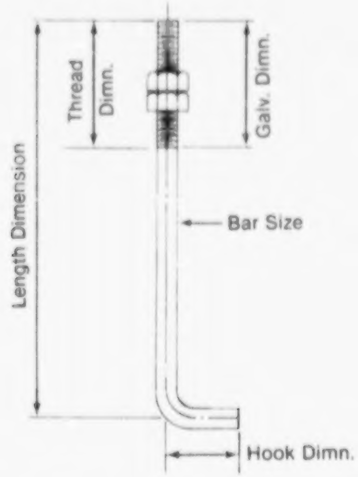
2. Machine bolt

Example:


Thread
Bolt Length Dimension

INFORMATION SHEET

3. Cane head anchor bolt (C.H.A.B.)



C. An alternative to drawing is to call out anchor bolts by diameter size, length, type, and bend dimensions if needed.

Example: An alternative to drawing

( ) ____ 0 × ____ C.H.A.B., ____ "BEND W/HVY HEX NUT & WASHER

D. Anchor bolt projects above top of grout a dimension equal to the sum of

1. Equipment base thickness
2. Two anchor bolt diameters for two nuts
3. One anchor bolt diameter

XIV. Types of concrete

A. Non-reinforced concrete — Has no mesh or reinforcing bars; used for places where only compression stresses occur

Example: Pump foundation

B. Reinforced concrete — Concrete reinforced with mesh or steel rebar to help transmit the stresses of compression, tension, and shear forces

XV. Types of concrete reinforcement

A. Reinforcing bar (rebar) (Transparency 8)

1. Identified by number which indicates size in eighths of an inch

   Example: #7 bar — Nominal diameter 7/8"

2. Rebar sizes range from #2 to #11 (#14 and #18 — special sizes)

INFORMATION SHEET

3. All rebar is deformed except #2 which is round bar.

4. Rebar is made from steel in lengths of 60 feet.

B. Wire mesh (welded wire fabric)

1. Used as reinforcement in concrete slabs

   Example: Paving

2. Made of deformed wire

3. Welded wire fabric (WWF) — Designated by wire spacing and wire gage

   Example: WWF 6 × 6 — 10/10 — Welded wire fabric, wire spaced six inches each way (6" square) and #10 gage thick

XVI. **Standard prestressed concrete units** (Transparency 9)

A. Channel slab

B. Wall panels and hollow core slabs

C. Columns, piles, and girders

D. Double and single tees

E. Mono-wing ("F") section

XVII. **Foundation parts** (Transparency 10-12)

A. Pedestal — Rest on the footer and used to support equipment such as pumps. Usually stop one foot above grade line.

B. Spread footing (footer) — Placed under the pedestal or foundation wall and serves as a bearing member

C. Pier — Generally round 12"-16" diameter concrete columns poured into drilled (augured) holes in the earth to solid bearing rock when expansive type (clay) soils are encountered. They are placed at 8'-0" (max) intervals to support grade beams.

D. Grade beam — Reinforced concrete beam that spans horizontally between piers for support of foundation wall. It replaces the spread footing in expansive soils.

E. Bell-bottomed footing — Used in soil where soil bearing is poor and footing is at a great depth

INFORMATION SHEET

F. Foundation (stem) wall — Used for support of wood framed walls and edge slab support as a method to distribute those loads to a spread footing or grade beam

G. Pilings — Precast, tapered, reinforced concrete shafts driven into the earth to provide support when mass of structure exceeds limits of soil bearing; usually high-rise structures require their use

H. Pilaster — Rectangular-shaped protrusions from masonry walls to provide additional lateral wall support especially where beams intersect the wall

XVIII. Types of structural drawings for concrete

A. Engineering drawing — Shows where concrete dimensions are but rebar details are omitted

B. Placing drawing — Shows the foundation outline without the outline dimensions but shows all rebar locations and dimensions (used by fabricators and in the field) and bar lists, schedules, and bending details

C. Preprinted drawing — Used for standard details. Drafter needs only to add dimensions, bolt quantity, and size, and assign rebar mark numbers and size.

D. Combined placing and engineering drawing

(NOTE: The ACI standard practice, *ACI 315*, recommends engineering and placing drawing to be separate, but if a drawing is not too congested, most firms will combine both drawings.)

1. Rebar placement is shown in the section or elevation.
2. Plan view shows engineering dimensions.

XIX. Standard symbols and abbreviations for concrete placing drawings

A. Symbols

#	To indicate size of deformed bar
ϕ	Plain rounds, as spirals
@	Spacing center to center
⇆	Direction in which bars extend
↔	Limits of area covered by bars

INFORMATION SHEET

B. Abbreviations

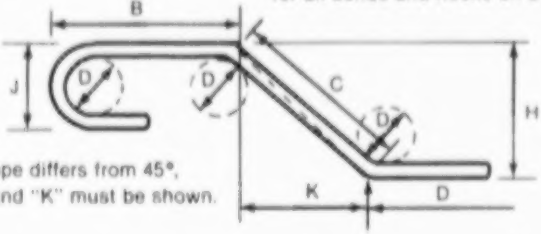
Bt	Bent	**NF**	Near Face
Bott	Bottom	**OF**	Outside Face
Cl	Clear	**Pl**	Plain Bar
EF	Each Face	**Sp**	Spiral
EW	Each Way	**Stir**	Stirrup
FF	Far Face	**Str**	Straight
IF	Inside Face	**T**	Top

XX. **Standard practices for documentation of rebar**

A. Rebar is dimensioned as out to out and the bar length is the sum of all detailed dimensions.

B. Rebars are at times bent.

Example:



Unless otherwise noted, diameter D is the same for all bends and hooks on a bar

Where slope differs from 45°, dimensions "H" and "K" must be shown.

C. Dimensions are to the outside, not centerline of rebar.

D. Rebar schedules (Transparency 13)

1. Give total length of bar required.
2. Letter designations are used for dimensions.
3. Show size, length, and weight of all rebar
4. Each bar is marked with an identifying number
    a. Drawing number
    b. Bar size and number

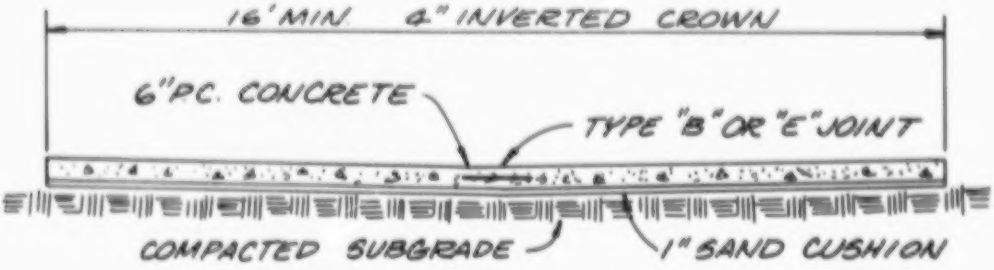
INFORMATION SHEET

E. Bar schedule must show the number of pieces, size, length, mark of bars, and bending details (a complete summary).

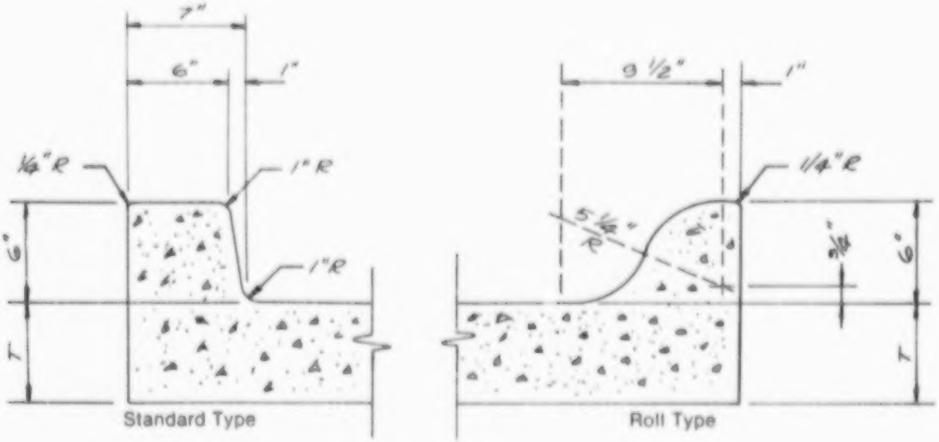
F. Reinforcing bars for foundations, piers, abutments, wing walls, and slabs are usually shown on the plan, section, or elevation.

XXI. Examples of typical details for concrete structures

A. Highway structures


16' MIN. 4" INVERTED CROWN
6" P.C. CONCRETE
TYPE "B" OR "E" JOINT
COMPACTED SUBGRADE
1" SAND CUSHION

Typical Paving Section for Alley


7"
6"
1"
1/4"R
1"R
1"R
6"
T
9 1/2"
1"
1/4"R
5 1/4" R
3/4"
6"
T

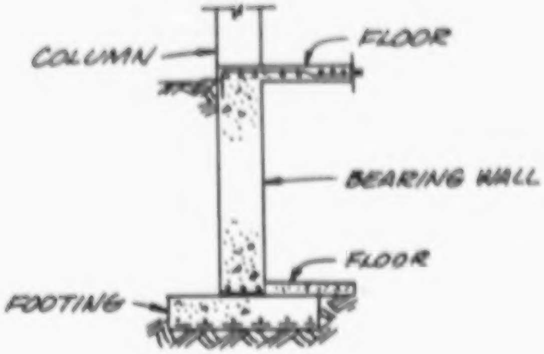
Standard Type

Roll Type

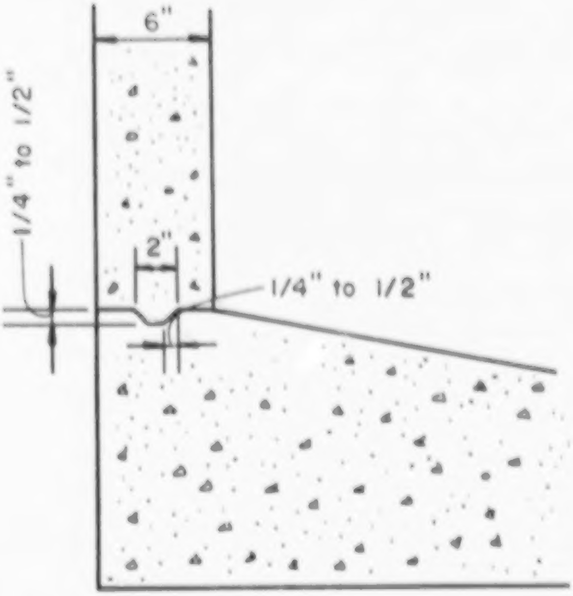
Curb Details

INFORMATION SHEET

B. Wall structures


COLUMN
FLOOR
BEARING WALL
FLOOR
FOOTING

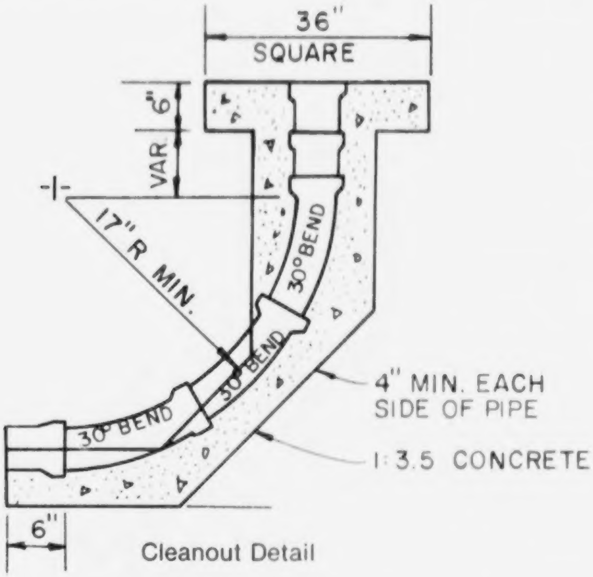
Section of Wall


6"
1/4" to 1/2"
2"
1/4" to 1/2"

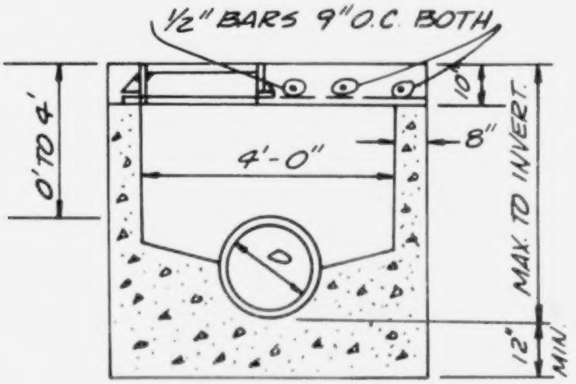
Key Construction Joint for Bottom and Walls

INFORMATION SHEET

C. Underground structures


36"
SQUARE
6"
VAR.
17" R MIN.
30° BEND
30° BEND
30° BEND
4" MIN. EACH SIDE OF PIPE
1:3.5 CONCRETE
6"

Cleanout Detail


1/2" BARS 9" O.C. BOTH
10"
8"
4'-0"
0' TO 4'
D
MAX. TO INVERT
12" MIN.

Shallow Manhole

XXII. Wood construction (by American Lumber standards)

A. Timber is lumber 5 inches or larger in the least dimension generally used for heavy wood members or construction.

B. Lumber is the product of the saw and planing mill.

C. Frame is usually applied to light wood construction.

D. Lumber dimensions are called out in nominal size; actual thickness and widths of seasoned and dressed lumber are less than nominal dimensions.

INFORMATION SHEET

XXIII. **Types of wood connectors** (Transparency 14)

A. Nails
   1. Common nail
   2. Casing nail
   3. Finishing nail
   4. Flooring nail
   5. Cut nail
   6. Boat spike

B. Screws
   1. Flat head screw
   2. Round head screw
   3. Fillister head screw
   4. Oval head screw
   5. Lag screw
   6. Drive screw

C. Bolts and nuts
   1. Carriage bolt
   2. Machine bolt
   3. Expansion bolt
   4. Toggle bolt

D. Washers
   1. Circular flat
   2. Circular ribbed
   3. Plate

INFORMATION SHEET

XXIV. Types of framing connectors (Transparencies 15 and 16)

A. Splice plate

B. Connector

C. Nail plate

D. Hinge plate

E. Web

F. Safety plate

G. U-clip

H. Romex

I. Hanger

J. Double member girder hanger

K. 45° hip jack hanger

L. 90° angle clip

M. Framing anchor

N. Tie down strap

O. Bridging

P. Seat plates

Q. Truss spacer

(NOTE: The numbers of connectors required in any joint is determined by the stresses in the members and the properties of the wood.)

XXV. Components of wood construction

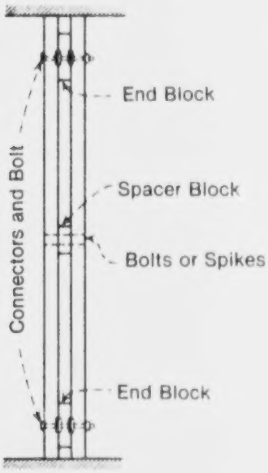
A. Columns and studs

1. Wood columns are square timbers rarely smaller than 4 × 4 inches and not larger than 12 × 12 inches.

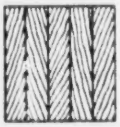
INFORMATION SHEET

2. Columns may be built up of small timbers.

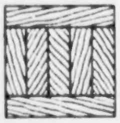
   Example:


End Block
Connectors and Bolt
Spacer Block
Bolts or Spikes
End Block

Spaced Column



Spiked or Glued Planks



Spiked Planks

3. Studs — Used for dwellings to carry light loads and receive support from the material attached to them.

B. Wood frame members

1. Types
   a. Floor and ceiling joists
   b. Rafters of sloping roofs
   c. Roof purlins
   d. Beams
      1) Plywood
      2) Laminated
      3) Trussed beams
   e. Girders
2. Wood frame construction
   a. Rafter — Common depth 4 — 8″
   b. Joists — Common depth 6 — 12 or 14″
3. Heavy timber — Minimum thickness permitted for joists, beams, girders, and other members is 6″ and minimum depth is 10″.

INFORMATION SHEET

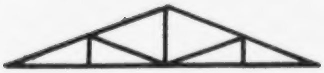
C. Wood trusses (Transparency 17)

1. Used to support roofs or floors

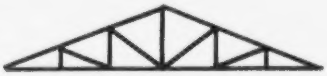
2. All members, joints, and trusses as a whole should be symmetrical with reference to a vertical plane.

3. Many types are available.

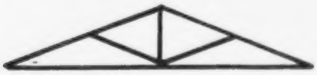
Examples:



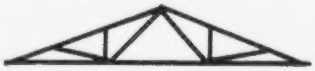
Howe



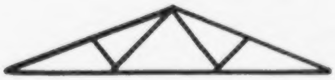
Double Howe



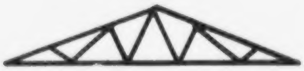
Fan



Double Fan



Fink



Double W

XXVI. Heavy timber construction (Transparencies 17 and 18)

A. Exterior walls are masonry or other noncombustible materials with a fire resistance rating of at least 2 hours.

B. Interior structural members are heavy timber — solid or laminated masses.

C. Floors and roofs are heavy plank or laminated wood.

D. Foundation walls are poured — concrete walls on spread foundations.

E. Member sizes are determined by the length of span.

F. First floor framing consists of longitudinal girders.

G. Interior girders are supported by wood columns, pipe, or steel structural shapes.

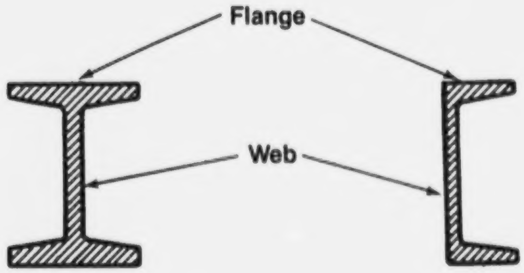
INFORMATION SHEET

H. Second floor framing consists of longitudinal girders supported by the wall and the interior columns.

I. Traverse beams span the distance between lines of girders and supported by metal hangers.

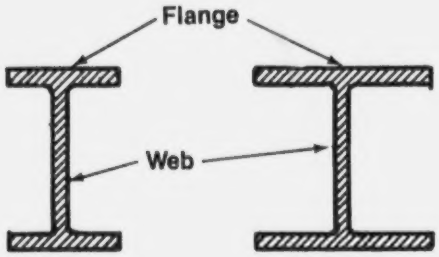
J. A tongue-and-groove or a laminated deck may span the space between beams.

Structural Steel Shapes



American Standard Beam

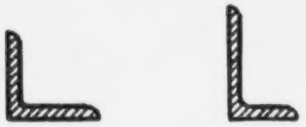
American Standard Channel



W Beam

W Column

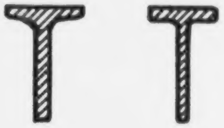
Wide Flange Shapes



Equal Legs

Unequal Legs

Angle Shapes (L)



ST

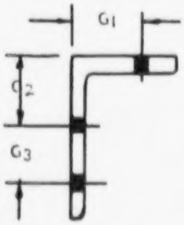
WT

Structural Tees

Plate (PL)

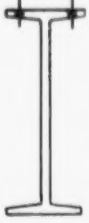
Flat Bar (Bar)

Gage Line Standards



GAGE	LEG SIZE (Inches) 8	6	5	4	3 1/2	3	2 1/2	2	1 3/4	1 3/8	1
G1	4 1/2	3 1/2	3 1/8	2 1/2	2 3/8	1 3/4	1 3/8	1 3/16	1	7/8	5/8
G2	3 1/8	2 3/8	1 3/4								
G3	3 1/8	2 1/2	2								

FLANGE WIDTH	G
2 3/8 to 2 3/4	1 1/2
3 to 3 3/8	1 3/4
3 1/2 to 4	2
4 to 4 3/4	2 1/8
5 to 5 3/4	3
6 to 7 1/4	3 3/4
7 1/2 to 8	5

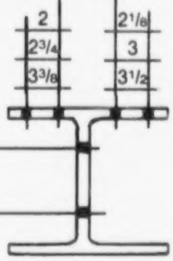


S Shapes

FLANGE WIDTH	G
1 3/8 to 1 1/2	3/4
1 3/4	1
1 3/4 to 2	1 3/16
2 1/8	1 3/16
2 1/8 to 2 3/8	1 3/8
2 1/2 to 2 3/4	1 1/2
2 7/8 to 3 1/8	1 3/4
3 3/8 to 3 5/8	2 1/8
3 3/4 to 4 3/8	2 1/2

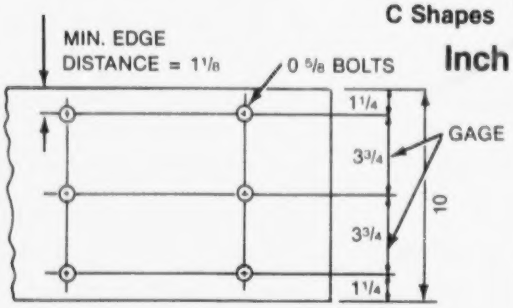
C Shapes

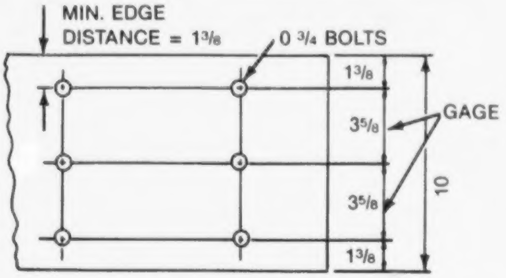
FLANGE WIDTH	G
4	2 1/8
5 to 5 3/4	3
6 to 7 1/8	3 3/4
7 1/2 and Up	5 1/8


2
2 3/4
3 3/8
2 1/8
3
3 1/2

DEPTH OF W AND M COLUMN	G
6	2 1/8
8	3 3/4
10 to 14	5

Inch Sizes


MIN. EDGE DISTANCE = 1 1/8
0 5/8 BOLTS
1 1/4
3 3/4
GAGE
3 3/4
1 1/4
10

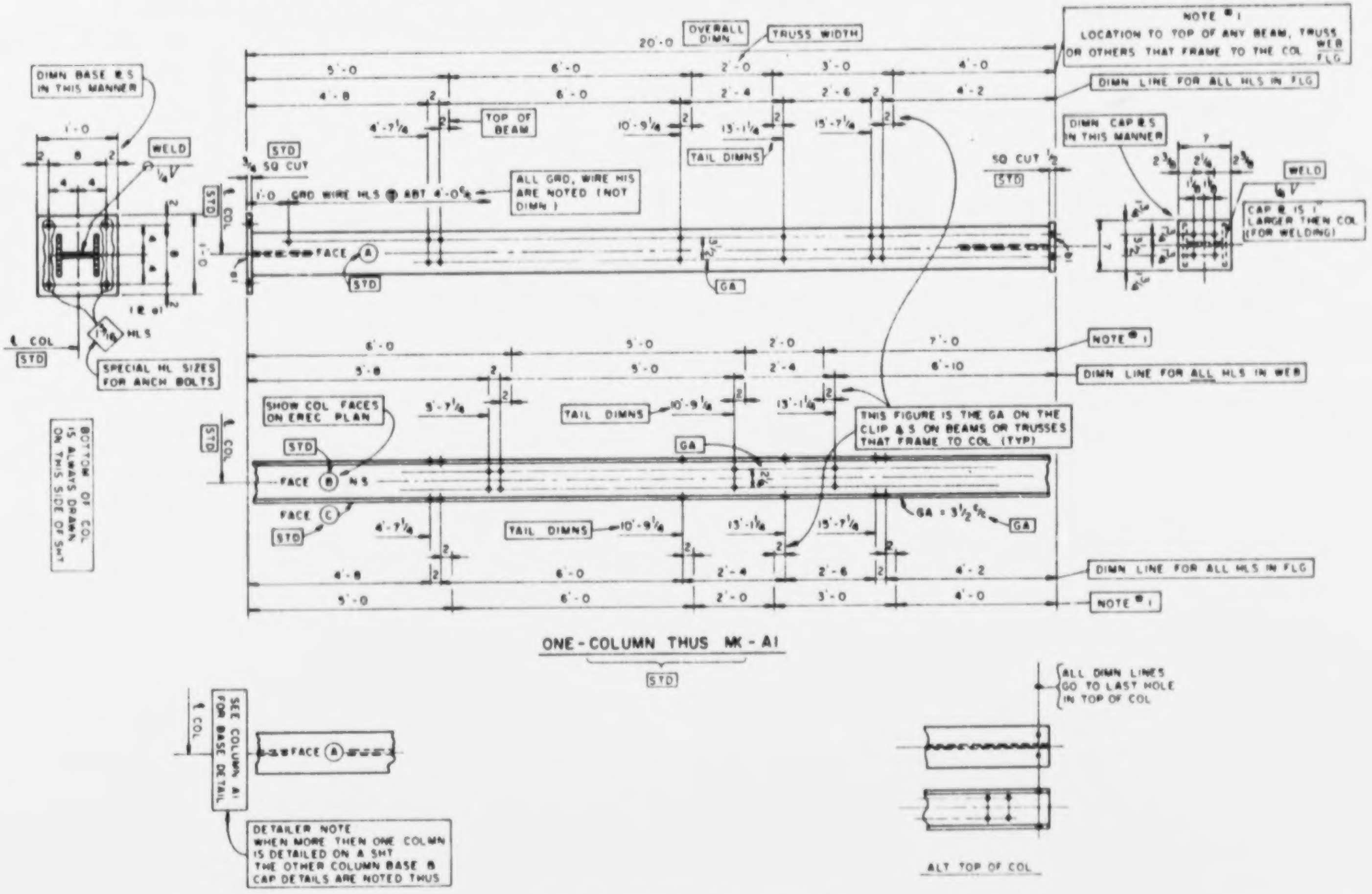

MIN. EDGE DISTANCE = 1 3/8
0 3/4 BOLTS
1 3/8
3 5/8
GAGE
3 5/8
1 3/8
10

Establishing Gage Sizes from Edge Distance

	Bolt Diameter	At Sheared Edge	At Rolled or Gas Cut Edge
U.S. Customary (Inches)	1/2	1	3/4
	5/8	1 1/8	7/8
	3/4	1 3/8	1
	7/8	1 1/2	1 1/8
	1	1 5/8	1 3/16
	1 1/8	1 3/4	1 3/8
	1 1/4	2	1 1/2
	1 3/8	2 1/2	1 13/16

Minimum Edge Distance for Bolt

Dimensioning Procedures for Structural Steel

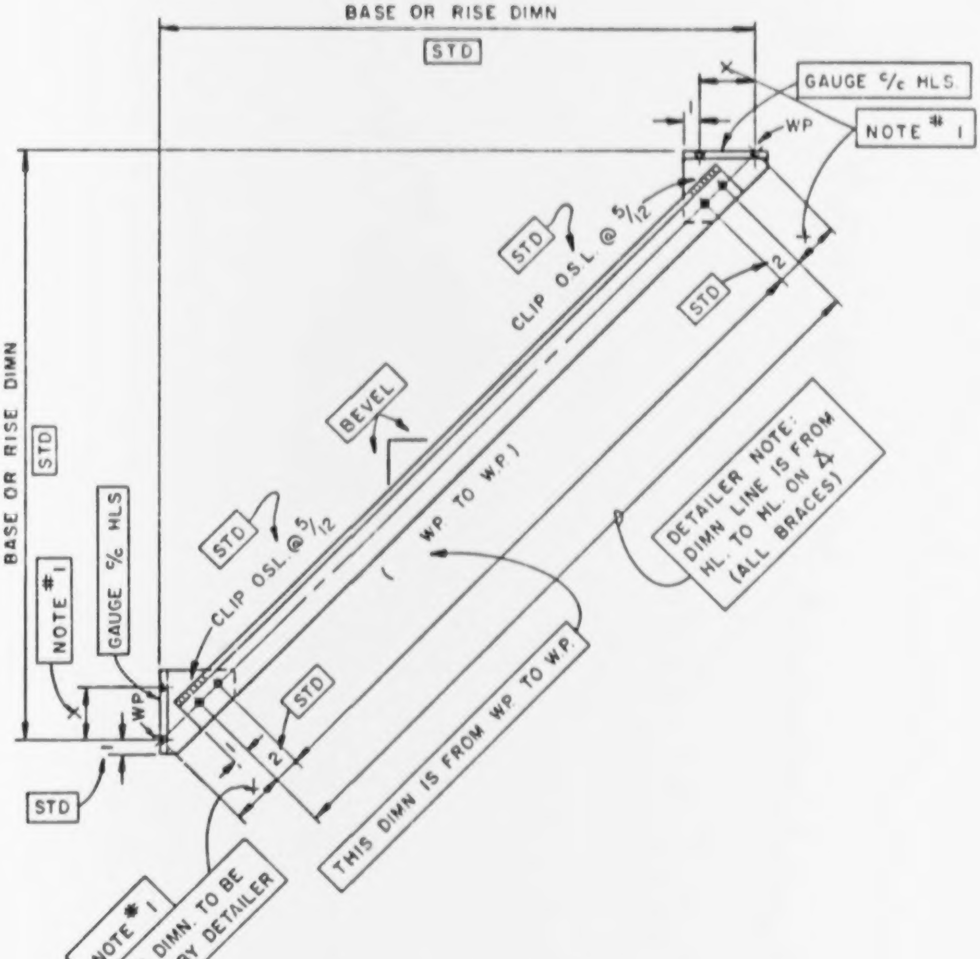

NOTE # 1
LOCATION TO TOP OF ANY BEAM, TRUSS OR OTHERS THAT FRAME TO THE COL WEB FLG
OVERALL DIMN
TRUSS WIDTH
20'-0
5'-0
6'-0
2'-0
3'-0
4'-0
4'-8
2'-4
2'-6
4'-2
DIMN LINE FOR ALL HLS IN FLG
DIMN BASE ⅊S IN THIS MANNER
1'-0
WELD
TOP OF BEAM
4'-7¼
10'-9¼
13'-1¼
15'-7¼
TAIL DIMNS
STD
3/4 SQ CUT
SQ CUT 1/2
DIMN CAP ⅊S IN THIS MANNER
1'-0 GRD WIRE HLS @ ABT 4'-0 c/c
ALL GRD. WIRE HLS ARE NOTED (NOT DIMN)
CAP ⅊ IS 1 LARGER THEN COL (FOR WELDING)
℄ COL
FACE A
GA
12 φ1
1 3/16 HLS
SPECIAL HL SIZES FOR ANCH BOLTS
NOTE # 1
6'-0
5'-0
2'-0
7'-0
5'-8
6'-10
DIMN LINE FOR ALL HLS IN WEB
BOTTOM OF COL IS ALWAYS DRAWN ON THIS SIDE OF SHT
SHOW COL FACES ON EREC PLAN
5'-7¼
TAIL DIMNS
THIS FIGURE IS THE GA ON THE CLIP ⅃S ON BEAMS OR TRUSSES THAT FRAME TO COL (TYP)
FACE B NS
FACE C
GA = 3½ c/c
DIMN LINE FOR ALL HLS IN FLG
NOTE # 1
ONE-COLUMN THUS MK-A1
STD
SEE COLUMN A1 FOR BASE DETAIL
FACE A
DETAILER NOTE
WHEN MORE THEN ONE COLMN IS DETAILED ON A SHT THE OTHER COLUMN BASE & CAP DETAILS ARE NOTED THUS
ALL DIMN LINES GO TO LAST HOLE IN TOP OF COL
ALT TOP OF COL

STANDARD METHOD FOR DETAILING
WF OR B SERIES COLUMNS

Courtesy of Public Service Company of Oklahoma

Dimensioning Procedures for Structural Steel

(Continued)


BASE OR RISE DIMN
STD
GAUGE c/c HLS.
NOTE # 1
X
1
WP
STD
CLIP O.S.L. @ 5/12
2
STD
BEVEL
WP TO W.P.
STD
CLIP O.S.L. @ 5/12
DETAILER NOTE: DIMN LINE IS FROM HL. TO HL. ON ℄ (ALL BRACES)
BASE OR RISE DIMN
STD
NOTE # 1
GAUGE c/c HLS
X
WP
STD
1
2
STD
X
THIS DIMN IS FROM WP. TO W.P.
NOTE # 1
THIS DIMN. TO BE CALC. BY DETAILER

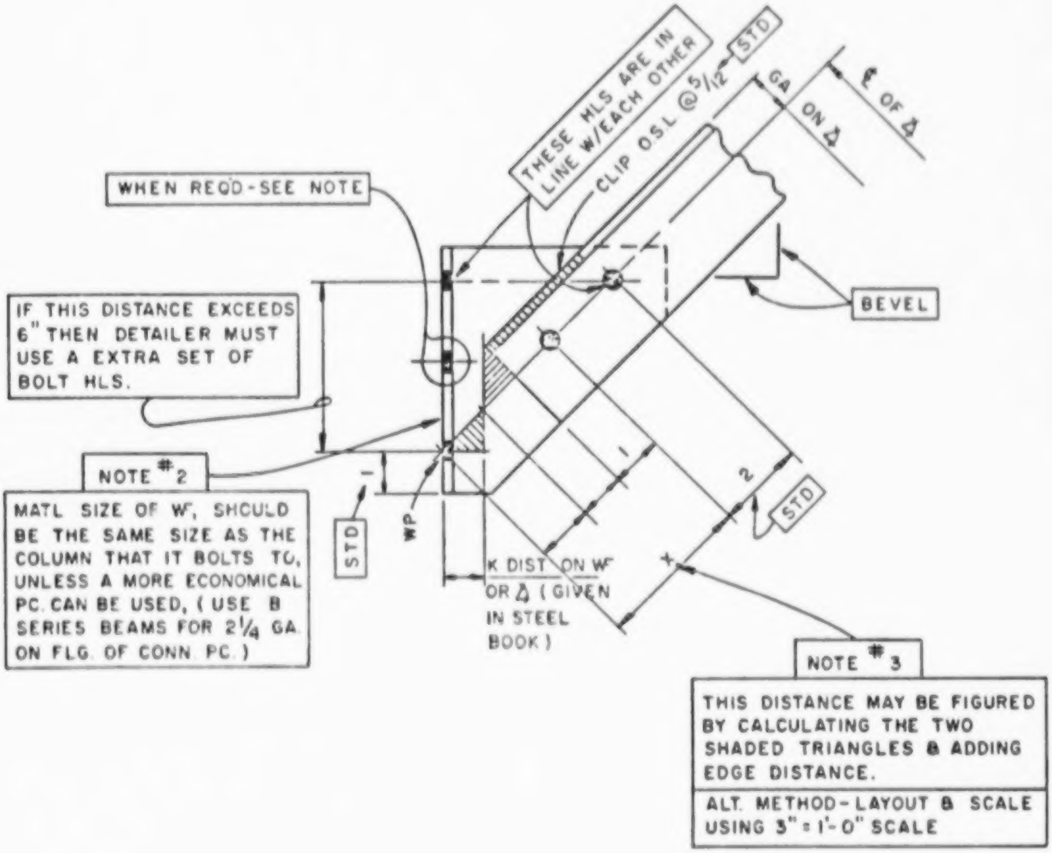
STD TYPE BRACE

(NORMALLY USED FOR KNEEBRACE)

Courtesy of Public Service Company of Oklahoma

Dimensioning Procedures for Structural Steel

(Continued)


THESE HLS ARE IN LINE W/EACH OTHER
CLIP O.S.L @ 5/12
STD
GA
ON ∆
℄ OF ∆
WHEN REQD-SEE NOTE
BEVEL
1
2
STD
STD
WP
K DIST ON WF OR ∆ (GIVEN IN STEEL BOOK)
X
NOTE #2
NOTE #3

IF THIS DISTANCE EXCEEDS 6" THEN DETAILER MUST USE A EXTRA SET OF BOLT HLS.

NOTE #2

MATL SIZE OF WF, SHOULD BE THE SAME SIZE AS THE COLUMN THAT IT BOLTS TO, UNLESS A MORE ECONOMICAL PC. CAN BE USED, (USE B SERIES BEAMS FOR 2¼ GA. ON FLG. OF CONN. PC.)

NOTE #3

THIS DISTANCE MAY BE FIGURED BY CALCULATING THE TWO SHADED TRIANGLES & ADDING EDGE DISTANCE.

ALT. METHOD - LAYOUT & SCALE USING 3" = 1'-0" SCALE

DETAIL NO. 1

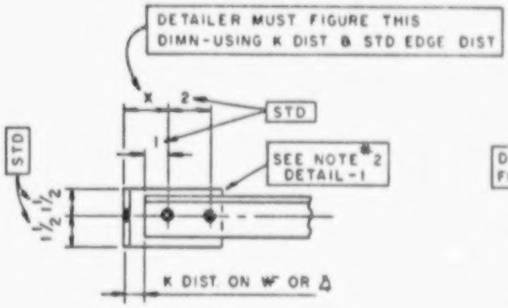
THE ABOVE METHOD SHOWS HOW TO CALCULATE THE DIMN FOR THE CONNECTING PC. OF A BRACE. THE CONNECTING PC. MAY BE AN ANGLE OR WF (USE WF WHERE POSSIBLE.) BUT BOTH CAN BE FIGURED THE SAME WAY.

Courtesy of Public Service Company of Oklahoma

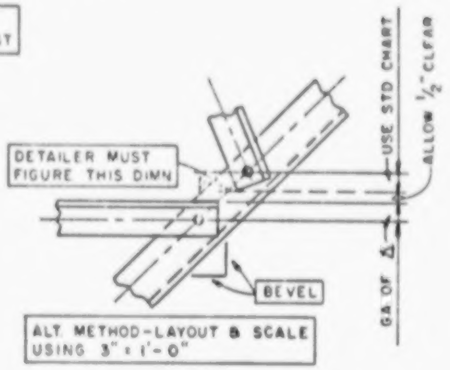
Dimensioning Procedures for Structural Steel

(Continued)

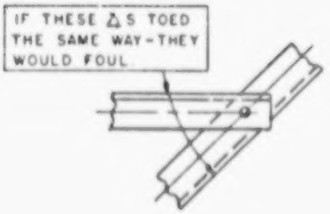
DRAFTING REFERENCE MANUAL


DETAILER MUST FIGURE THIS DIMN-USING K DIST & STD EDGE DIST
X
2
STD
1
SEE NOTE *2 DETAIL-1
STD
1½ 1½
K DIST. ON W OR ∠

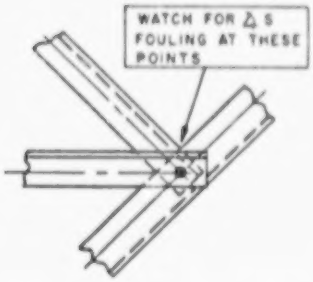
DETAIL NO. 2


DETAILER MUST FIGURE THIS DIMN
USE STD CHART
ALLOW ½" CLEAR
GA. OF ∠
BEVEL
ALT. METHOD-LAYOUT & SCALE USING 3" = 1'-0"

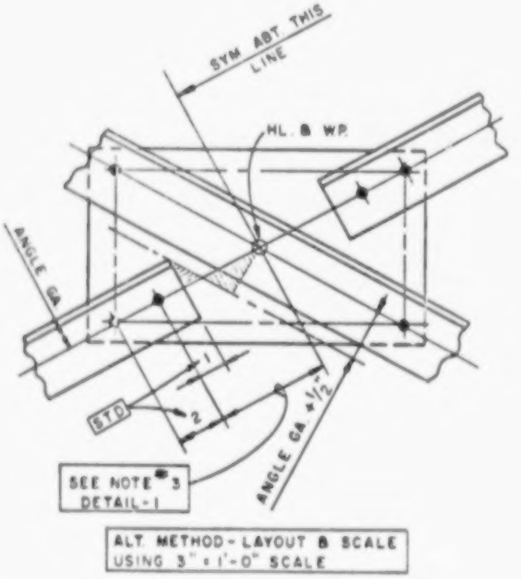
DETAIL NO. 3


IF THESE ∠S TOED THE SAME WAY-THEY WOULD FOUL

DETAIL NO. 4


WATCH FOR ∠S FOULING AT THESE POINTS

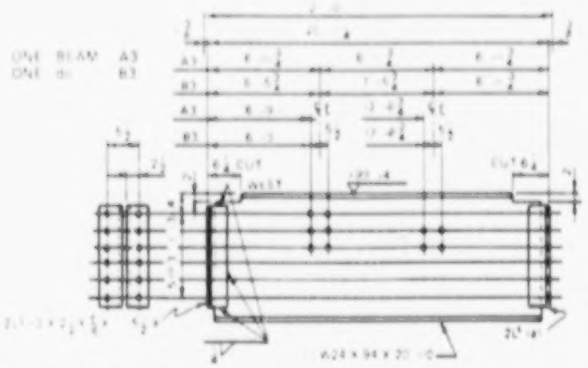
DETAIL NO. 5


SYM ABT THIS LINE
HL. & WP.
ANGLE GA.
1
STD
2
ANGLE GA. + ½"
SEE NOTE *3 DETAIL-1
ALT. METHOD - LAYOUT & SCALE USING 3" = 1'-0" SCALE

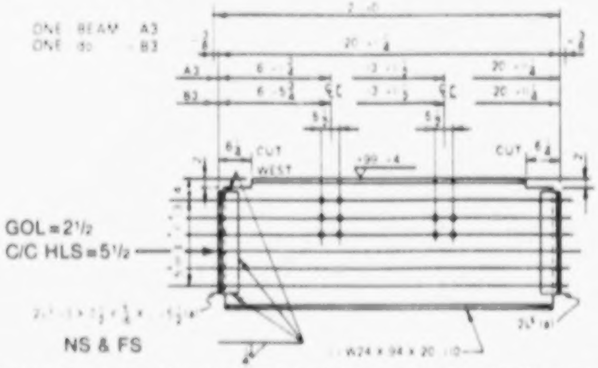
DETAIL NO. 6

Courtesy of Public Service Company of Oklahoma

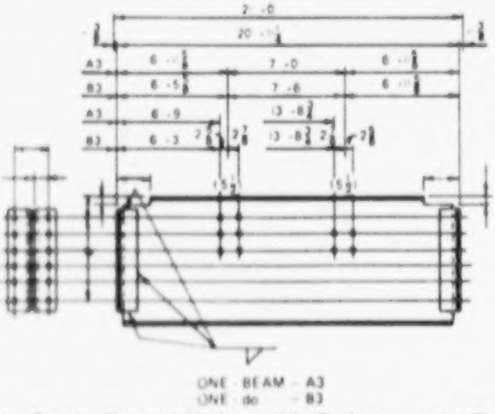
Dimensioning Beam Channels


ONE BEAM A3
ONE do B3
A3
B3
CUT
WEST
CUT
W24 x 94 x 20

Dimensioning to Centerline of Channel Webs and Centerline of Holes from Left End of Beam


ONE BEAM A3
ONE do B3
A3
B3
CUT
WEST
CUT
GOL = 2½
C/C HLS = 5½
NS & FS
W24 x 94 x 20

Dimensioning from the Left End of Beam to Centerline of Channel Webs


A3
B3
A3
B3
7 -0
7 -6
13 -8¾
ONE BEAM A3
ONE do B3

Dimensioning to Centerline of Holes with Reference to Backs of Channels

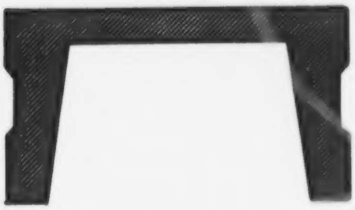
Courtesy of Public Service Company of Oklahoma

Rebar Data

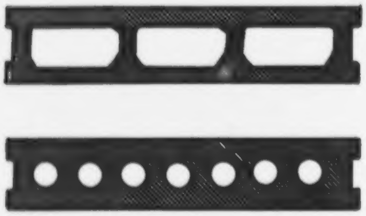
Standard ASTM A-305 Reinforcing Bars

Bar Size number	Weight # Per Foot	Diameter, Inches	Cross Sectional Area, Sq. Inches	Perimeter, Inches
2	0.167	0.250	0.05	0.786
3	0.376	0.375	0.11	1.178
4	0.668	0.500	0.20	1.571
5	1.043	0.625	0.31	1.963
6	1.502	0.750	0.44	2.356
7	2.044	0.875	0.60	2.749
8	2.670	1.000	0.79	3.142
9	3.400	1.128	1.00	3.544
10	4.303	1.270	1.27	3.990
11	5.313	1.410	1.56	4.430
Special ASTM A-408 Reinforcing Bars				
14S	7.65	1.693	2.25	5.32
18S	13.60	2.257	4.00	7.09

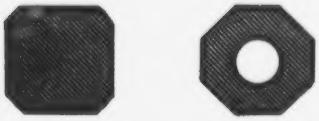
Standard Prestress Concrete Units



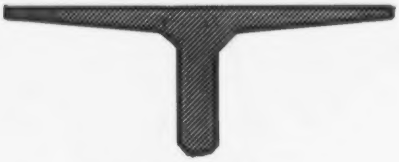
Channel Slab



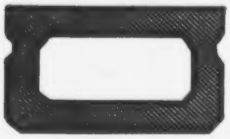
Hollow Core Slabs



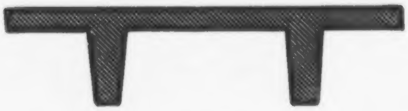
Columns and Piles



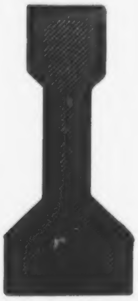
Single Tee



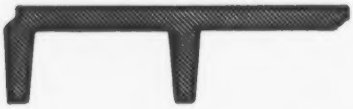
Box Girder



Double Tee

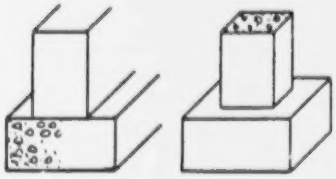


"I" Girder

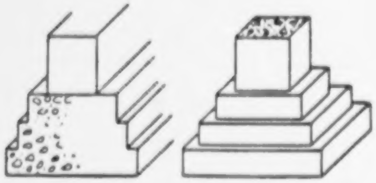


Mono-Wing ("F") Section

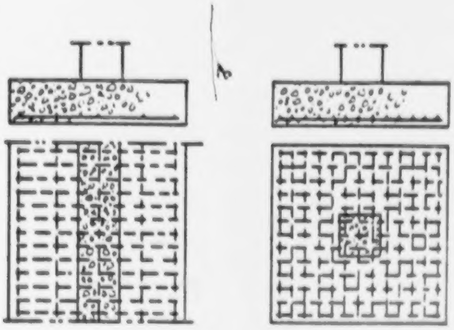
Examples of Foundation Parts



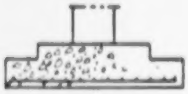
Simple Footings



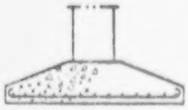
Plain Stepped Footings



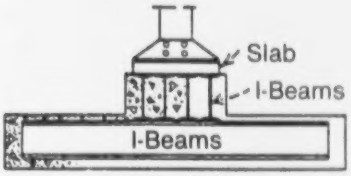
Slab Footings



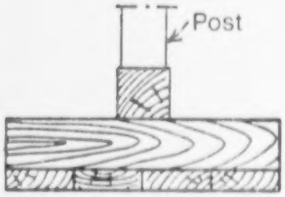
Stepped



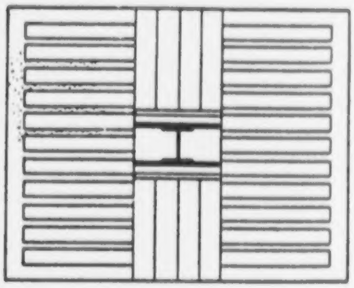
Sloped


Slab
I-Beams
I-Beams

Elevation



Timber Grillage Footing

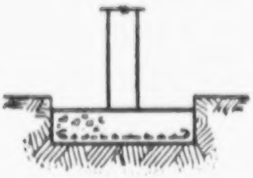


Plan

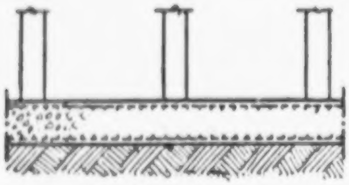
Steel Grillage Footing

Examples of Foundation Parts

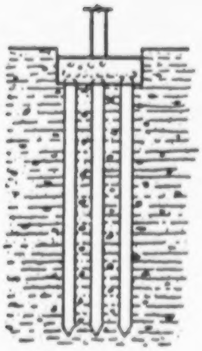
(Continued)



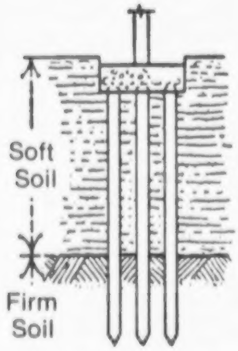
Reinforced Concrete Column Footing



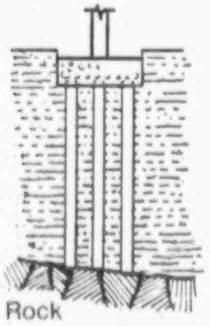
Reinforced Concrete Mat or Raft



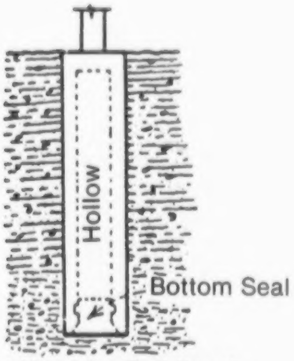
Piles in Soil


Soft Soil
Firm Soil

Piles through Soft Soil into Firm Soil

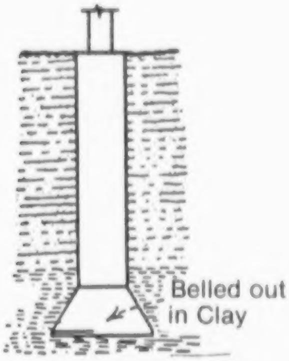


Piles Bearing on Rock

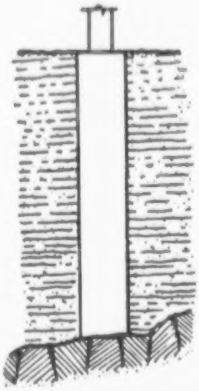

Hollow
Bottom Seal

(Not Used for Buildings)

Piers in Soil


Belled out in Clay

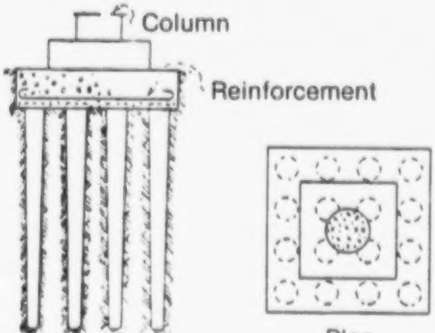
Piers on Firm Clay or Hardpan



Piers on Rock

Examples of Foundation Parts

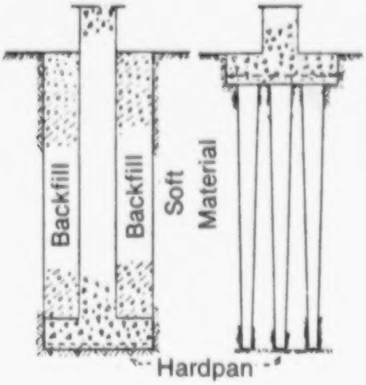
(Continued)


Column
Reinforcement

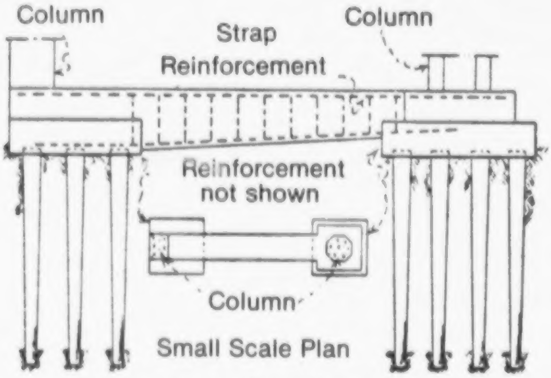
Elevation

Plan

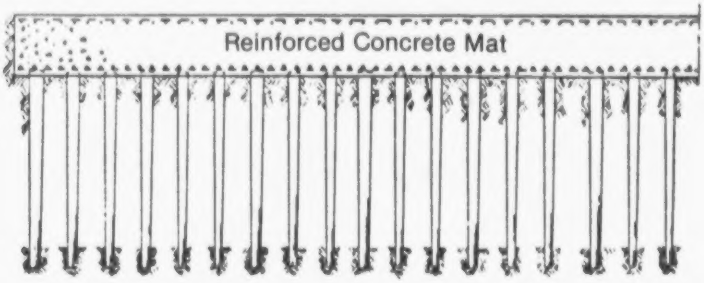
Footing on Piles


Backfill
Backfill
Soft
Material
Hardpan

Use of Piles to Carry Footing

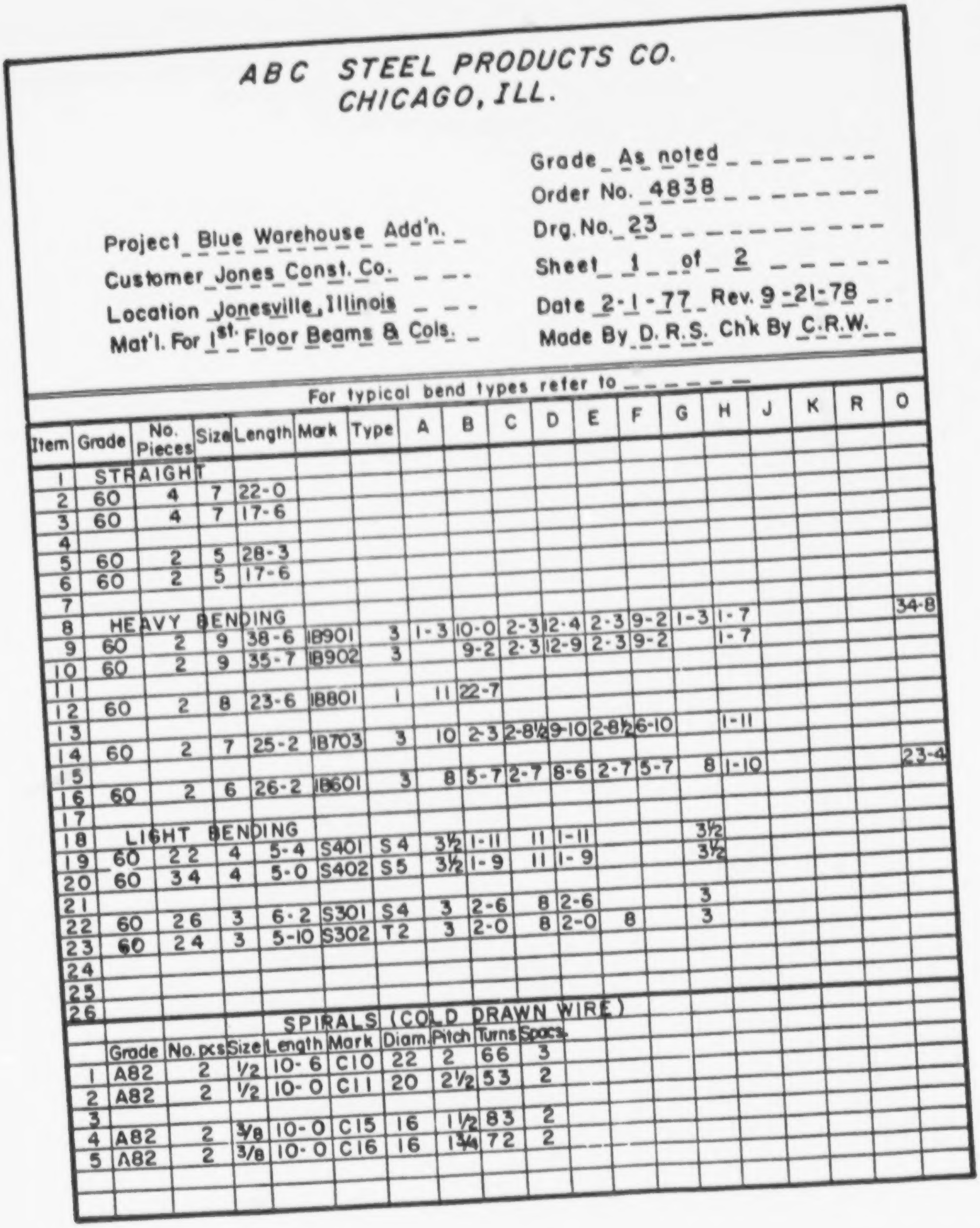

Column
Strap
Reinforcement
Column
Reinforcement
not shown
Column
Small Scale Plan

Reinforced Concrete Cantilever Footing on Piles


Reinforced Concrete Mat

Reinforced Concrete Mat Footing on Piles

Typical Bar List



ABC STEEL PRODUCTS CO.
CHICAGO, ILL.

Grade As noted
Order No. 4838
Project Blue Warehouse Add'n.
Drg. No. 23
Customer Jones Const. Co.
Sheet 1 of 2
Location Jonesville, Illinois
Date 2-1-77 Rev. 9-21-78
Mat'l. For 1st. Floor Beams & Cols.
Made By D. R. S. Ch'k By C.R.W.

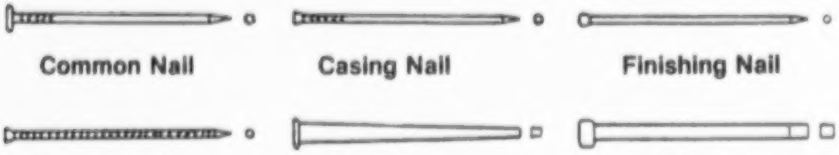
For typical bend types refer to

Item	Grade	No. Pieces	Size	Length	Mark	Type	A	B	C	D	E	F	G	H	J	K	R	O
1	STRAIGHT																	
2	60	4	7	22-0														
3	60	4	7	17-6														
4																		
5	60	2	5	28-3														
6	60	2	5	17-6														
7																		
8	HEAVY BENDING																	
9	60	2	9	38-6	IB901	3	1-3	10-0	2-3	12-4	2-3	9-2	1-3	1-7				34-8
10	60	2	9	35-7	IB902	3		9-2	2-3	12-9	2-3	9-2		1-7				
11																		
12	60	2	8	23-6	IB801	1	11	22-7										
13																		
14	60	2	7	25-2	IB703	3	10	2-3	2-8½	9-10	2-8½	6-10		1-11				
15																		
16	60	2	6	26-2	IB601	3	8	5-7	2-7	8-6	2-7	5-7	8	1-10				23-4
17																		
18	LIGHT BENDING																	
19	60	22	4	5-4	S401	S4	3½	1-11	11	1-11			3½					
20	60	34	4	5-0	S402	S5	3½	1-9	11	1-9			3½					
21																		
22	60	26	3	6-2	S301	S4	3	2-6	8	2-6			3					
23	60	24	3	5-10	S302	T2	3	2-0	8	2-0		8	3					
24																		
25																		
26																		

SPIRALS (COLD DRAWN WIRE)

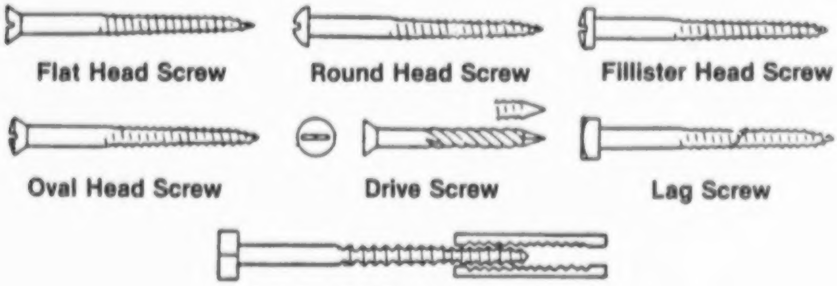
	Grade	No. pcs	Size	Length	Mark	Diam.	Pitch	Turns	Spacs.
1	A82	2	½	10-6	C10	22	2	66	3
2	A82	2	½	10-0	C11	20	2½	53	2
3									
4	A82	2	3/8	10-0	C15	16	1½	83	2
5	A82	2	3/8	10-0	C16	16	1¾	72	2

Common Wood Connectors



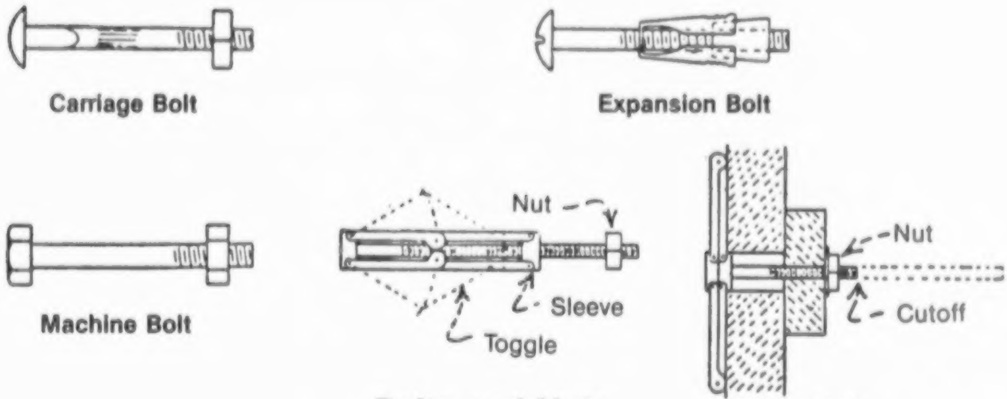
Common Nail
Casing Nail
Finishing Nail
Flooring Nail
Cut Nail
Boat Spike

Nails



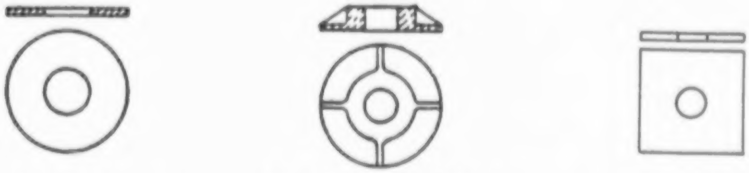
Flat Head Screw
Round Head Screw
Fillister Head Screw
Oval Head Screw
Drive Screw
Lag Screw
Expansion Shield for Lag Screw

Screws



Carriage Bolt
Expansion Bolt
Machine Bolt
Toggle Bolt

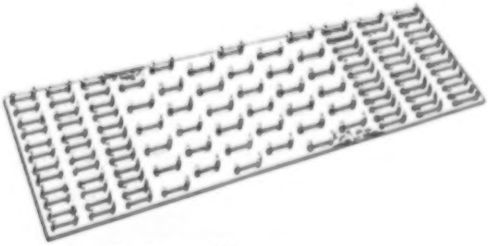
Bolts and Nuts



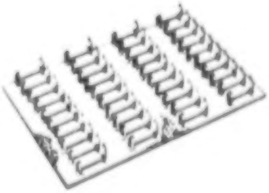
Circular Flat Washer
Circular Ribbed Washer
Plate Washer

Washers

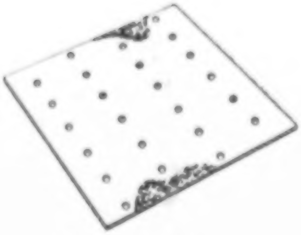
Framing Connectors



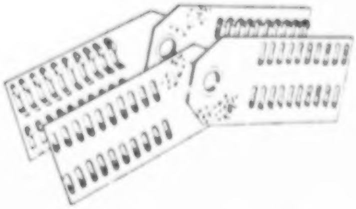
Splice Plate



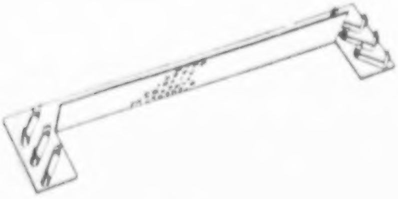
Connector



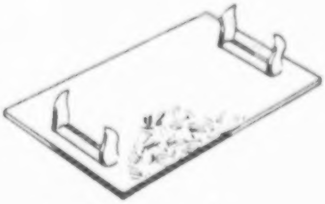
Nail Plate



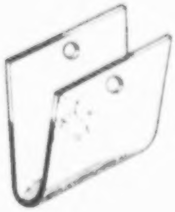
Hinge Plate



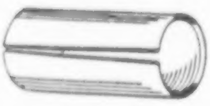
Web



Safety Plate



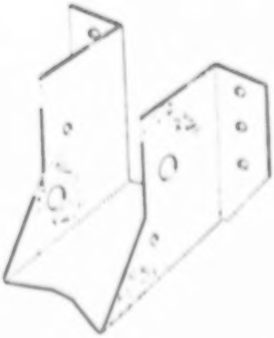
U-Clip

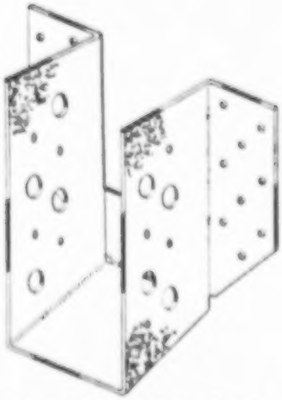


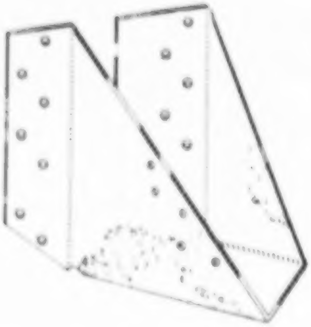
Romex

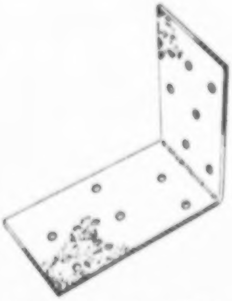
Framing Connectors

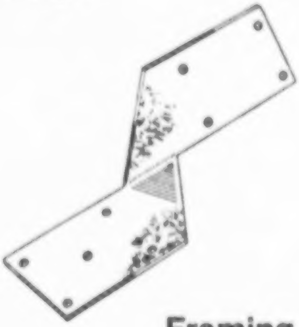
(Continued)


Hanger

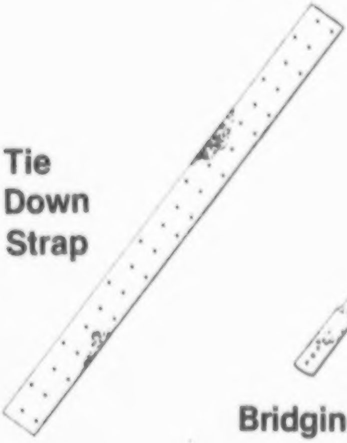
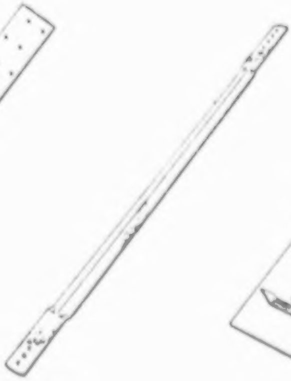

Double Member Girder Hanger

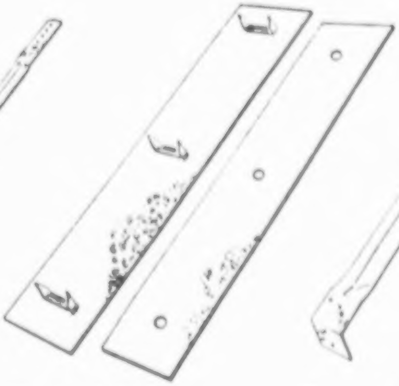

45° Hip Jack Hanger

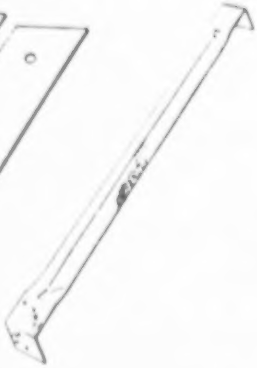

90° Angle Clip


Framing Anchor

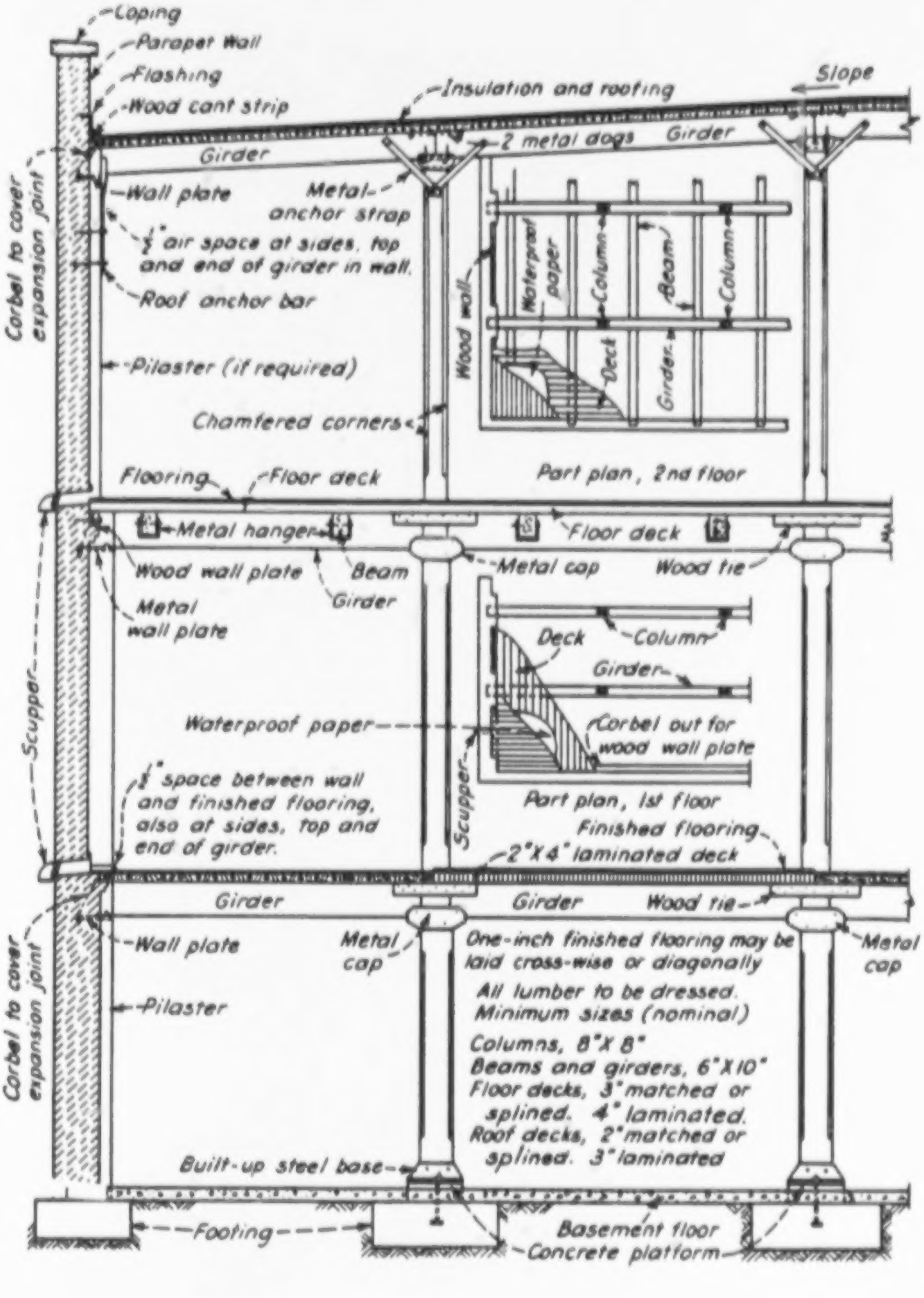
Tie Down Strap



Bridging


Seat Plates

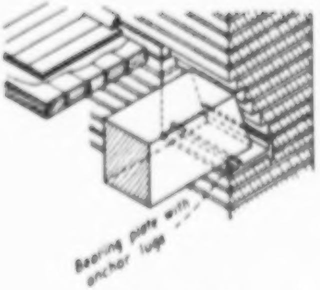

Truss Spacer

Heavy Timber Construction

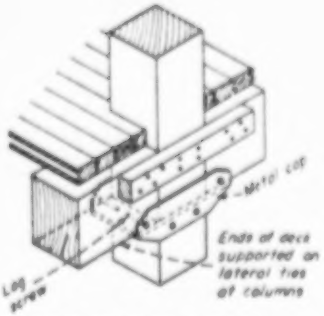

Coping
Parapet Wall
Flashing
Wood cant strip
Insulation and roofing
Slope
2 metal dogs
Girder
Girder
Wall plate
Metal anchor strap
½" air space at sides, top and end of girder in wall.
Roof anchor bar
Corbel to cover expansion joint
Pilaster (if required)
Wood wall
Waterproof paper
Column
Beam
Column
Deck
Girder
Chamfered corners
Part plan, 2nd floor
Flooring
Floor deck
Metal hanger
Floor deck
Wood wall plate
Beam
Metal cap
Wood tie
Girder
Metal wall plate
Deck
Column
Girder
Scupper
Waterproof paper
Corbel out for wood wall plate
Scupper
Part plan, 1st floor
½" space between wall and finished flooring, also at sides, top and end of girder.
Finished flooring
2"X4" laminated deck
Girder
Girder
Wood tie
Wall plate
Metal cap
One-inch finished flooring may be laid cross-wise or diagonally
Metal cap
All lumber to be dressed.
Minimum sizes (nominal)
Columns, 8"X 8"
Beams and girders, 6"X10"
Floor decks, 3" matched or splined. 4" laminated.
Roof decks, 2" matched or splined. 3" laminated
Corbel to cover expansion joint
Pilaster
Built-up steel base
Footing
Basement floor
Concrete platform

Heavy Timber Construction

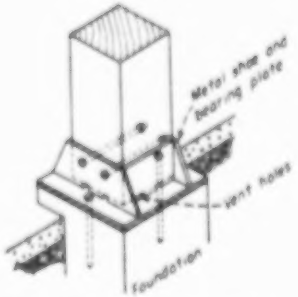
(Continued)


Bearing plate with anchor lugs

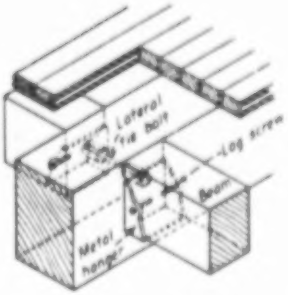
Girder Bearing
on Metal Plate Wall


Metal cap
Ends of decs supported on lateral ties of columns
Log screw

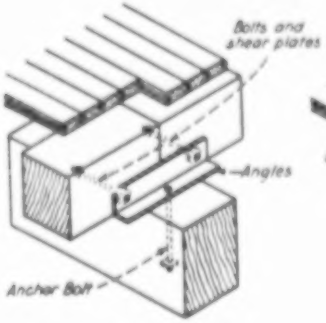
Metal Column Cap
with Two Brackets


Metal shoe and bearing plate
Vent holes
Foundation

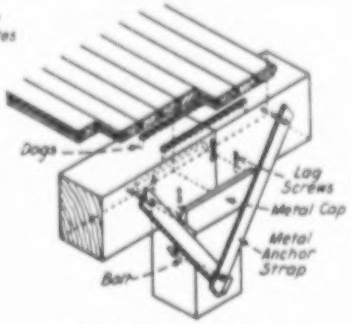
Built-Up Steel Column


Lateral tie bolt
Log screw
Beam
Metal hanger

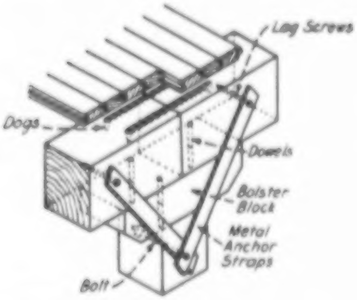
Metal Beam Hanger


Bolts and shear plates
Angles
Anchor Bolt

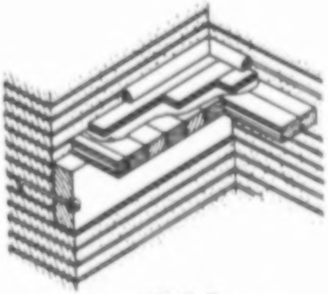
Beams Supported
on Top of Girder


Dogs
Log Screws
Metal Cap
Metal Anchor Strap
Bolt

Metal Column Cap
Supporting Roof Girders


Log Screws
Dogs
Dowels
Bolster Block
Metal Anchor Straps
Bolt

Wood Bolster Block Supporting
Roof Girders



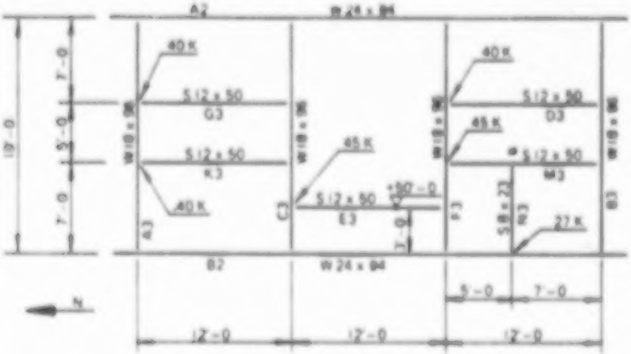
Wall Beam

Courtesy of the National Lumber Manufacturers' Association

STRUCTURAL DRAFTING
UNIT XI

ASSIGNMENT SHEET #1 — PREPARE DETAIL DRAWINGS OF STRUCTURAL STEEL MEMBERS

Given: Floor plan


A2
W 24 x 84
40 K
S 12 x 50
G3
S 12 x 50
K3
40 K
A3
W 18 x 96
W 18 x 96
45 K
C3
S 12 x 50
E3
+50'-0
1'-0
40 K
S 12 x 50
D3
45 K
S 12 x 50
M3
S 8 x 23
N3
27 K
F3
W 18 x 96
W 18 x 96
G3
19'-0
7'-0
5'-0
7'-0
B2
W 24 x 84
N
5'-0
7'-0
12'-0
12'-0
12'-0

ELEVATION: TOP OF STEEL TO BE (+50'-3) UNLESS OTHERWISE SHOWN
NOTES: ALL HOLES Ø 13/16 BOLTS Ø 3/4–A325

Directions: Use the *AISC Manual of Steel Construction* for reference.

1. Set up the final drawing "B" or "C" size vellum.
2. Use scale ³/₈" = 1'0".
3. Prepare complete detail drawings of beams D3, E3, M3, N3, and C3 using framed beam connections. Refer to the transparencies as needed.
    a. Dimension to centerline of channel webs.
    b. Connection angles are welded to the beams. (Use ³/₁₆ fillet weld.)
    c. Outstanding angles are bolted to the connecting beams.
4. Make sketches of beam connections. Scale 1" = 1'0"

STRUCTURAL DRAFTING
UNIT XI

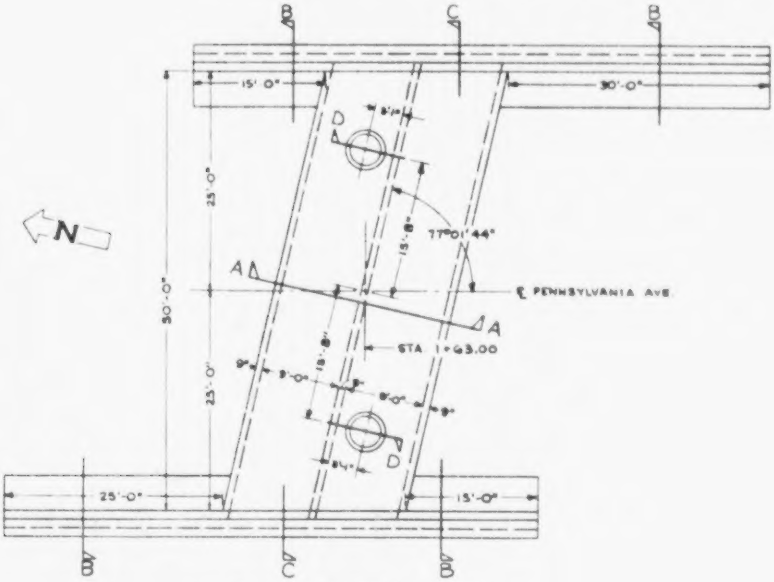
ASSIGNMENT SHEET #2 — DRAW TO SCALE A CONCRETE ENGINEERING DRAWING

Given: Reduced set of plans for a culvert

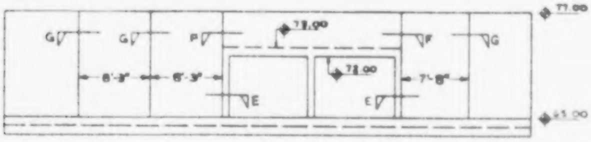
Directions:

1. Redraw to scale.
2. Use "D" size format.
3. Use pencil on vellum or film lead on Mylar.
4. Draw the engineering drawing to the scales given on the reduced set of plans.
5. Hand letter general notes or type on film and adhere to drawing.
6. Hand letter all dimensions.
7. Observe all standard procedures for drafting.

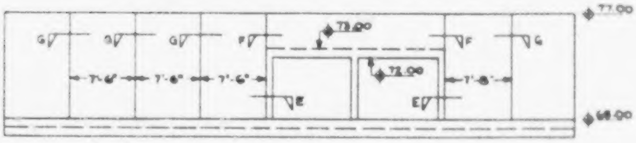
ASSIGNMENT SHEET #2


B
C
B
15' 0"
30'-0"
D
8'1"
25'-0"
N
15'-8"
77°01'44"
A
℄ PENNSYLVANIA AVE.
A
30'-0"
STA. 1+63.00
15'-8"
25'-0"
9"
9'-0"
9"
9'-0"
9"
D
8¼"
25'-0"
15'-0"
B
C
B

PLAN VIEW OF CULVERT
1/8" = 1'-0"


77.00
G
G
F
72.00
F
G
72.00
8'-3"
8'-3"
7'-8"
E
E
63.00

WEST ELEVATION
1/8" = 1'-0"

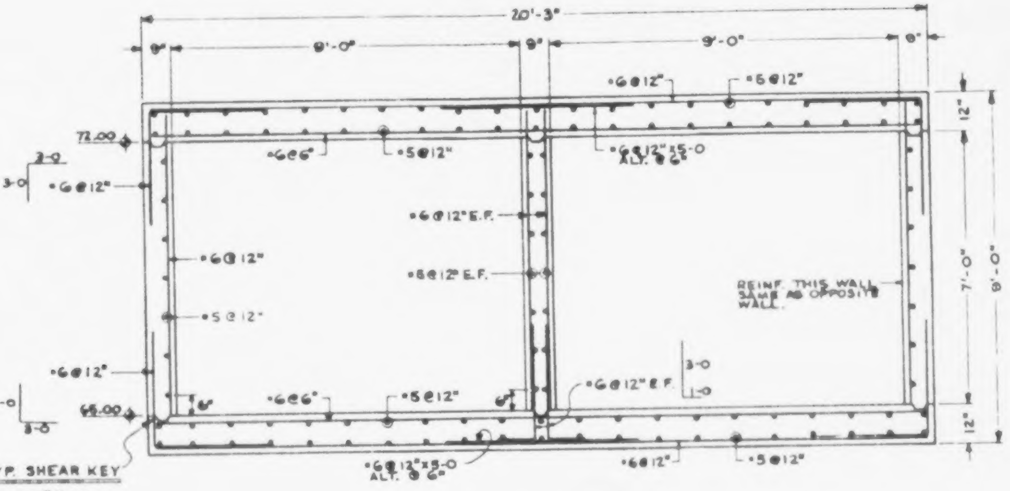

77.00
G
G
G
F
72.00
F
G
72.00
7'-6"
7'-6"
7'-6"
7'-8"
E
E
68.00

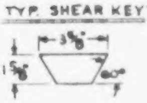
EAST ELEVATION
1/8" = 1'-0"

GENERAL NOTES

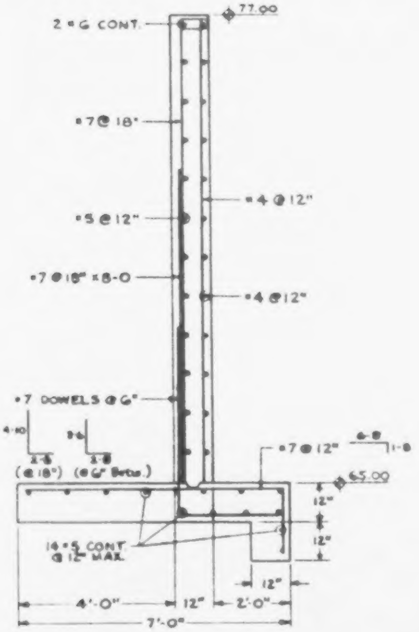
1. Concrete, 3000PSI-ASTM C94.
2. Reinforcing steel, 60,000 PSI, ASTM A615, Grade 60.
3. Unless otherwise noted, clear cover over all reinforcement shall be 2 in.
4. Chamfer all exposed edges 3/4 in.
5. All vertical and top of exposed concrete wall surfaces shall be cleaned and rubbed to conform to Sec. 2, Paragraph E(2) of the specifications. The earth side of concrete walls shall be rubbed from the top down a distance of 1 ft.
6. Minimum reinforcing steel lap splice shall be 36 bar diameters.

ASSIGNMENT SHEET #2

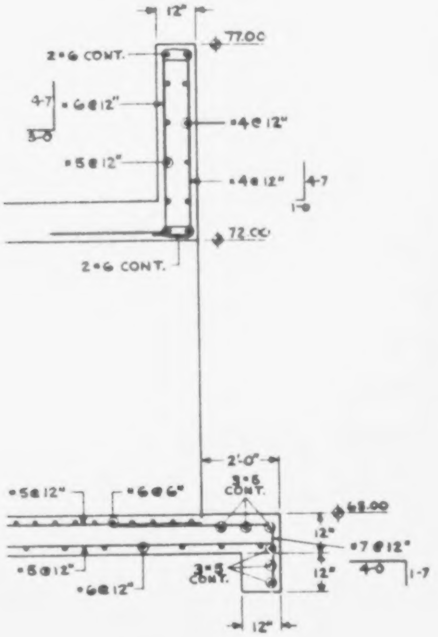

20'-3"
9"
9'-0"
9"
9'-0"
9"
#6@12"
#5@12"
72.00
#6@6"
#5@12"
#6@12" x5-0 ALT. @ 6"
3-0
3-0
#6@12"
#6@12" E.F.
#6@12"
#6@12" E.F.
#5@12"
REINF. THIS WALL SAME AS OPPOSITE WALL.
12"
7'-0"
9'-0"
#6@12"
3-0
3-0
3-0
1-0
6"
#6@6"
#5@12"
6"
#6@12" E.F.
65.00
12"
#6@12" x5-0 ALT. @ 6"
#6@12"
#5@12"


TYP. SHEAR KEY
3⅝"
1⅝"
60°

SECTION A-A
½" = 1'-0"

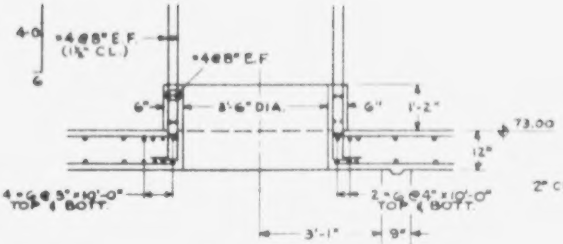

2 #6 CONT.
77.00
#7@18"
#4@12"
#5@12"
#7@18" x8-0
#4@12"
#7 DOWELS @ 6"
4-10
2-8
(@ 18")
3-6
2-8
(@ 6" Betw.)
#7@12"
6-8
1-8
65.00
12"
12"
14 #5 CONT. @ 12" MAX.
12"
4'-0"
12"
2'-0"
7'-0"

SECTION B
½" = 1'-0"

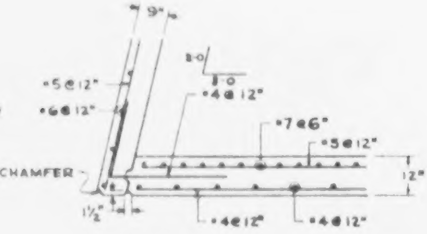

12"
77.00
2 #6 CONT.
4-7
3-0
#6@12"
#4@12"
#5@12"
#4@12"
4-7
1-0
72.00
2 #6 CONT.
2'-0"
#5@12"
#6@6"
3 #6 CONT.
65.00
12"
#7@12"
4-0
1-7
12"
#5@12"
#6@12"
3 #5 CONT.
12"

SECTION C
½" = 1'-0"

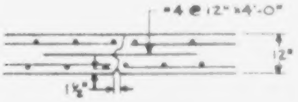
ASSIGNMENT SHEET #2


4-0
6
#4@8" E.F. (1½" CL.)
#4@8" E.F
6"
8'-6" DIA.
6"
1'-2"
73.00
12"
4-#6@5" x10'-0" TOP & BOTT.
2-#6@4" x10'-0" TOP & BOTT.
3'-1"
9"

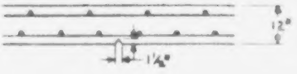
SECTION D
½" = 1'-0"


9"
#5@12"
#6@12"
3-0
3-0
#4@12"
#7@6"
#5@12"
2" CHAMFER
12"
1½"
#4@12"
#4@12"

SECTION E
½" = 1'-0"


#4@12" x4'-0"
12"
1½"

SECTION F
½" = 1'-0"



SECTION G
½" = 1'-0"

FLOOD CONTROL PROJECT I-5
RED BLUFF CA

TWO BARREL CULVERT
HAYES STREET

B JONES & ASSOCIATES
LOS ANGELES CA

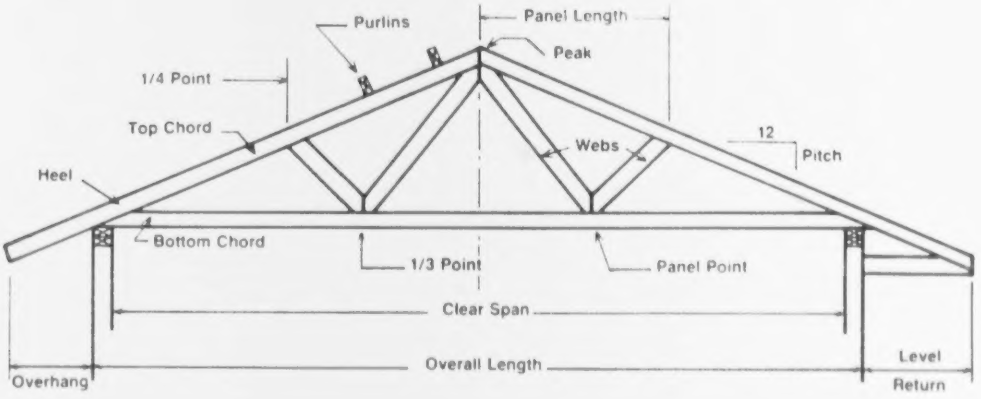
DRAWN BY BTE
DATE 4-20-79
REV
DWG HE-9

DRAWING HE-9

STRUCTURAL DRAFTING
UNIT XI

ASSIGNMENT SHEET #3 — DETAIL A WOOD TRUSS

Given: Example of a common truss


Purlins
Panel Length
Peak
1/4 Point
Top Chord
Webs
12
Pitch
Heel
Bottom Chord
1/3 Point
Panel Point
Clear Span
Overall Length
Level
Return
Overhang

Directions:

Part A: Complete a detail drawing of a common wood truss. Use pencil on vellum and a scale of 1/4″ = 1′-0″. specifications:

Common truss specifications:

Overall length — 28′-0″	Pitch — 4
Top chord — 2×4	Sou pine #2 KD 15
Bottom chord — 2×4	Sou pine #2 KD 15
Webs — 2×4	Sou pine #3 KD 15
Truss plate	20 gage
Top chord live load	20.0 PSF
Top chord dead load	10.0 PSF
Bottom chord dead load	10.0 PSF
Total uniform load	40.0 PSF
Load adjustment	15%
Truss spacing	2.00 ft ctrs

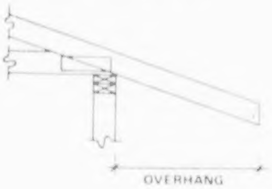
ASSIGNMENT SHEET #3

Overhang — Calculate the allowable overhang using the following chart

MAXIMUM OVERHANG WITHOUT SUPPORT
TRUSS SPACING 2'0" CENTERS

LOAD PSF	20LL, 10DL		30LL, 10DL		40LL, 10DL	
LUMBER SIZE	2 × 4	2 × 6	2 × 4	2 × 6	2 × 4	2 × 6
SOUTHERN PINE KD						
#2 1.6E	4 - 1	6 - 0	3 - 6	5 - 2	3 - 2	4 - 8
#2 DEN 1.7E	4 - 1	6 - 7	3 - 7	5 - 8	3 - 3	5 - 1
#1 1.8E	4 - 2	6 - 8	3 - 8	5 - 9	3 - 4	5 - 2
DOUGLAS FIR MC19						
#2 1.7E	4 - 0	5 - 11	3 - 5	5 - 1	3 - 1	4 - 7
#1 1.8E	4 - 2	6 - 5	3 - 8	5 - 7	3 - 4	5 - 0

Plumb Cut Shown.
Square Cut Dotted.



Part B: Estimate the number of common wood trusses required for a structure that is rectangular, 28'-0" wide by 56'-0" in length, with two gable ends.

Answer: ______________________

Instructions to calculate truss requirements:

Step 1 — Determine the 24" on-center truss requirements by dividing the length of the building by 2.

Step 2 — Add one truss to this total to provide a starting point.

Step 3 — Determine the number of gable ends required and subtract from the total truss requirement.

STRUCTURAL DRAFTING
UNIT XI

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheets #1 — Evaluated to the satisfaction of the instructor

Assignment Sheet #2 — Evaluated to the satisfaction of the instructor

Assignment Sheet #3

Part A — Evaluated to the satisfaction of the instructor

Part B — Step 1: 56′0″ length ÷ 2 = 28′

Step 2: 28 + 1 = 29

Step 3: 29 − 2 Gable Ends = 27

Answer — 27 trusses

STRUCTURAL DRAFTING
UNIT XI

NAME ______________________

TEST

1. Match the terms on the right with the correct definitions.

(NOTE: The terms on this page match the definitions on this page.)

______a. A force caused by loads being placed on a member that causes a squeezing or shortening effect on the member

______b. A vertical compression member, usually supporting beams and girders

______c. The top and bottom projection or outstanding parts of a beam, channel, or girder

______d. The top or bottom members of a truss

______e. The space between two consecutive sets or tiers of columns and beams, or columns and trusses

______f. A fluid mixture of cement, water, and sand which can be poured to fill small voids or to smooth or level a surface of a wall or footing

______g. The main member of a truss running along its lower side between supports and usually carrying tension and bending

______h. To cut out a part of the top or bottom flange of a beam or channel so that it may fit another

______i. A vertical flamework, usually columns and beams supporting other members

______j. The line along which fastener holes are punched or drilled in structural members

______k. A mixture of portland cement, fine aggregate, coarse aggregate, and water

______l. A member designed to carry bending stress, usually supporting other members

______m. That horizontal measurement between the inside faces of the two bearings or supports

1. Bay
2. Bent
3. Bottom chrord
4. Chord
5. Clear span
6. Column
7. Compression
8. Concrete
9. Cope
10. Flange
11. Gaze line
12. Girder
13. Grout

TEST

(NOTE: The terms on this page match the definitions on this page.)

______n. The horizontal members spanning from truss to truss, upon which the roof is carried

______o. A unit of force working within a member expressed in pounds per square inch

______p. A structural member designed to carry the wall over a window, door, or other opening

______q. Horizontal distance between the outside edges of supports

______r. A bar used in slip joints for expansion joints

______s. A steel or timber framework whose members take only tension or compression stresses

______t. The line where locating dimensions are given

______u. A unit part of some larger structure

______v. The space between two purlins in a roof or between two vertical members in a bridge truss

______w. A round, square, or deformed bar used to reinforce concrete

______x. The wood members used to support the roof in conventional framing

______y. A plate connecting the several members of a truss or other structural framework

______z. The edge point where dimensions are given

______aa. Main member of a truss running along its upper side supporting the decking and usually carrying combined compression and bending

______bb. Concrete that is precast or cast in place that has wires or cables that are stretched before the concrete is placed around them; the releasing of the wires or cables sets up internal stresses that counteract the external stresses of the applied load to prevent cracking and sagging

______cc. The portion of an I-beam, channel, or girder between the upper and lower flanges

14. Gusset plate
15. Lintel
16. Nominal span
17. Panel
18. Prestressed concrete
19. Purlin
20. Rafter
21. Rebar
22. Smooth bar
23. Steel member
24. Stress
25. Top chord
26. Truss
27. Web
28. Working line
29. Working point

TEST

2. Define structural drawing.

____

____

3. List four types of structures.

a. ____

b. ____

c. ____

d. ____

4. List three types of materials used for structures.

a. ____

b. ____

c. ____

5. Match types of steel members on the right with the correct characteristics or descriptions.

(NOTE: Members on the right may be used more than once.)

_____a. Form the principal supports of all steel structures other than bridges and similar spans which rest directly upon masonry and concrete

_____b. Are used wherever a comparatively large area is to be covered without intermediate columns

_____c. Generally are composed of a single piece

_____d. Are beams made of more than one piece

_____e. Are usually made with a web plate and flanges composed of angles, plates, or both, used to resist bending due to transverse loads

_____f. For the through type, the floor load is applied along the lower chord, and traffic flows through it.

1. Beams
2. Girders
3. Columns
4. Roof trusses
5. Bridge trusses

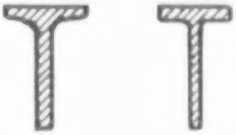
TEST

_____g. Generally are placed horizontally and are subjected to vertical loads

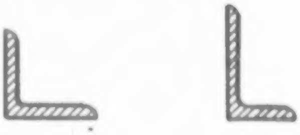
_____h. The web members are made of single or double angles with the longer legs vertical.

_____i. On the deck type, the floor load is applied along the upper chord

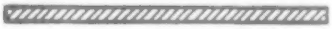
6. Identify the following structural steel shapes.



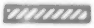
a. ______________________________



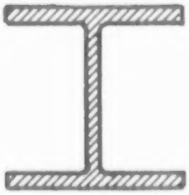
b. ______________________________



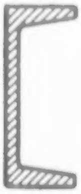
c. ______________________________



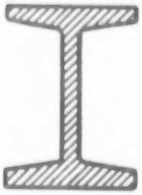
d. ______________________________



e. ____________________



f. ____________________



g. ____________________

7. Select true statements about drawing practices for steel members by placing an "X" next to the true statements.

_____a. A scale of 1" = 1'-0" is typically used for drawing a large structures (framing and erection plans).

_____b. No scale is used for most detail drawings (except on joints and trusses).

TEST

______c. Double line drawings are used when the scale doesn't allow for a lot of detail.

______d. The design drawing prepared by the designer/architect gives the structural detailer information to set up complete detail drawings.

______e. Large members such as trusses and plate girders are symmetrical about a centerline and only one half is detailed.

8. Describe the placement of gage lines for the following steel members.

   a. Angles — ______________________________

   b. Flange of a channel — ______________________________

   c. Flange of an I-beam — ______________________________

9. Complete the following statements concerning fastener sizes and spacings by circling the correct words.

   a. Minimum distance for fastener spacing along the gage line has been established by the (**AISC, ACI**).

   b. The minimum fastener size is governed by the following rule: The diameter of the fastener should never be (**less, more**) than the thickness of the metal punched.

10. Complete the following statements concerning dimensioning procedures for steel structures by circling the correct words.

    a. Use (**unidirectional, aligned**) method for locating dimensions.

    b. Dimensions are in feet and inches and should be placed (**in the middle, on top**) of the dimension line.

    c. Longest and overall dimension should be (**closest to, farthest away from**) the view.

    d. Dimensions should be placed no closer than ($\frac{5}{16}$", $\frac{1}{2}$") apart and the first line should be no closer than double this distance.

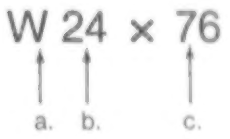
    e. Dimensions should be given to (**centerline, backs**) of beams.

    f. Dimensions should be given to the top (**or, and**) bottom of beams and channels.

    g. The slope of all members should be given in (**rise and run, angles**).

TEST

11. Label the following structural steel callout.



a. ____

b. ____

c. ____

12. Select true statements concerning structural steel marking procedures by placing an "X" next to the true statements.

_____a. Marks are used to provide a systematic procedure for detailing, fabricating, and erection.

_____b. Each member of a structure is given a mark on the design layout.

_____c. Mark is painted on the piece and used to erect the structure in the field.

_____d. Every company uses the same system of marking.

13. Complete statements concerning anchor bolts by filling in the blanks with the correct words.

a. Anchor bolts are used for ____________ ____________ to concrete foundations.

b. One type of anchor bolt is the ____________ ___.

c. An alternative to drawing is to call out anchor bolts by diameter size, ____________, type, and bend dimension if needed.

d. Anchor bolt projects above top of grout a dimension equal to the sum of the following:

   1) ____________

   2) Two anchor bolt diameters for two nuts

   3) One anchor bolt diameter

TEST

14. Distinguish between the types of concrete by placing an "X" next to the description of reinforced concrete.

______a. Has no mesh or rebars; used for places where only compression stresses occur

______b. Has mesh or steel rebar to help transmit the stresses of compression, tension, and shear forces

15. Complete the following statements concerning the types of concrete reinforcement by circling the correct words.

a. Reinforcing bar (rebar) is identified by number which indicates size in (**quarters, eighths**) of an inch.

b. Rebar sizes range from #2 to (**#6, #11**).

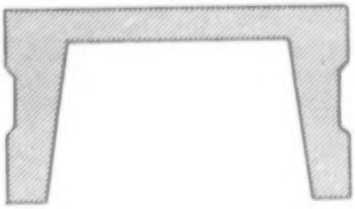
c. All rebar is deformed except (**#2, #6**) which is round bar.

d. Rebar is made from (**cast iron, steel**) in lengths of 60 feet.

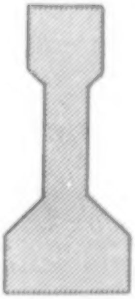
e. Wire mesh (welded wire fabric) is used as reinforcement in (**concrete slabs, steel columns**).

f. Welded wire fabric (WWF) is designated by wire spacing and (**type of wire, wire gage**).

16. Identify the following standard prestressed concrete units.

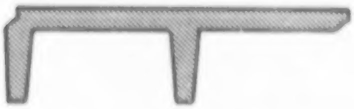


a. ______________________________

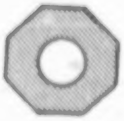


b. ______________________________

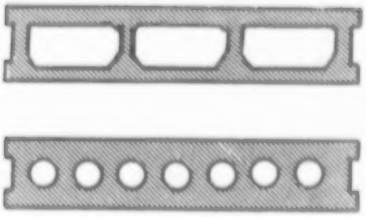
TEST



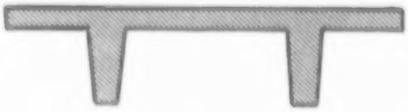
c. ____________________



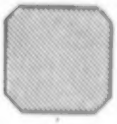
d. ____________________



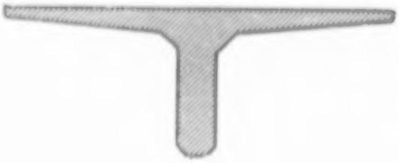
e. ____________________



f. ____________________



g. ____________________



h. ____________________

TEST

17. Match the foundation parts on the right with the correct descriptions.

______a. Rest on the footer and used to support equipment such as pumps. Usually stop one foot above grade line.

______b. Placed under the pedestal or foundation wall and serves as a bearing member

______c. Generally round 12"-16" diameter concrete columns poured into drilled (augured) holes in the earth to solid bearing rock when expansive type (clay) soils are encountered. They are placed at 8'-0" (max) intervals to support grade beams.

______d. Reinforced concrete beam that spans horizontally between piers for support of foundation wall. It replaces the spread footing in expansive soils.

______e. Used in soil where soil bearing is poor and footing is at a great depth

______f. Used for support of wood framed walls and edge slab support as a method to distribute those loads to a spread footing or grade beam

______g. Precast, tapered, reinforced concrete shafts driven into the earth to provide support when mass of structure exceeds limits of soil bearing; usually high-rise structures require their use

______h. Rectangular-shaped protrusions from masonry walls to provide additional lateral wall support especially where beams intersect the wall

1. Bell-bottomed footing
2. Foundation (stem) wall
3. Grade beam
4. Pedestal
5. Pier
6. Pilaster
7. Pilings
8. Spread footing (footer)

TEST

18. Match types of structural drawings for concrete on the right with the correct descriptions.

_____a.	Used for standard details. Drafter needs only to add dimensions, bolt quantity and size, and assign rebar mark numbers and size.	1. Engineering drawing
_____b.	Shows where concrete dimensions are but rebar details are omitted	2. Placing drawing
_____c.	Shows the foundation outline without the outline dimensions but shows all rebar locations and dimensions (used by fabricators and in the field) and bar lists, schedules, and bending details	3. Preprinted drawing

19. Complete the following chart of standard symbols and abbreviations for concrete placing drawings.

SYMBOLS		ABBREVIATIONS	
_____	To indicate size of deformed bar	Bt	__________
_____	Plain rounds, as spirals	T	__________
_____	Spacing center to center	_____	Each face
⇆	__________	Str	__________
↔	__________	NF	__________

20. Select true statements concerning standard practices for documentation of rebar by placing an "X" next to the true statements.

_____a. Rebar is dimensioned as out to out and the bar length is the sum of all detailed dimensions.

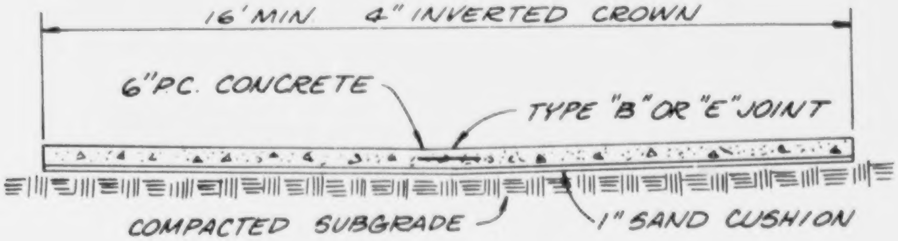
_____b. Rebars should never be bent.

_____c. Dimensions are to the centerlines of rebars.

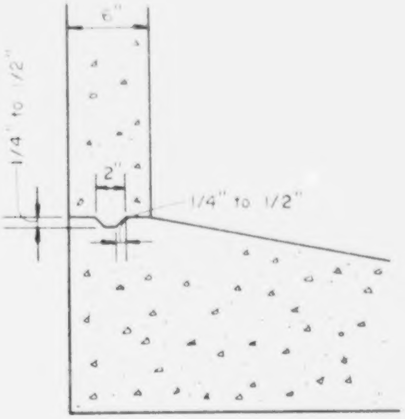
_____d. Rebar schedules give total lengths of bars required and show sizes, lengths, and weights of all rebars.

TEST

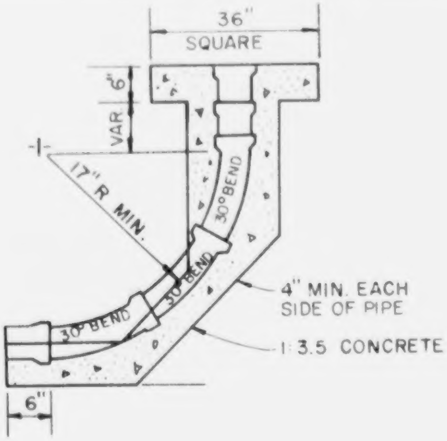
21. Identify the following examples of typical details for concrete structures.


16' MIN. 4" INVERTED CROWN
6" P.C. CONCRETE
TYPE "B" OR "E" JOINT
COMPACTED SUBGRADE
1" SAND CUSHION

a. ______________________________

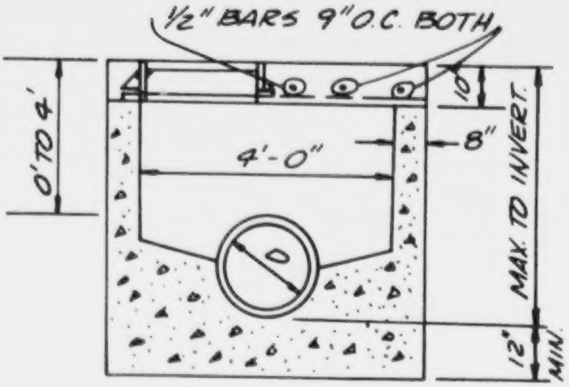

6"
1/4" to 1/2"
2"
1/4" to 1/2"

b. ______________________________


36"
SQUARE
6"
VAR
17" R MIN.
30° BEND
30° BEND
30° BEND
4" MIN. EACH SIDE OF PIPE
1:3.5 CONCRETE
6"

c. ______________________________

TEST



Shallow Manhole

d. ______________________________

22. Complete the following statements concerning wood construction by circling the correct words.

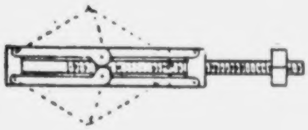
    a. (**Frame, Timber**) is lumber 5 inches or larger in the least dimension generally used for heavy wood members or construction.

    b. (**Timber, Lumber**) is the product of the saw and planing mill.

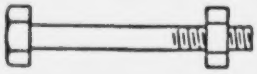
    c. (**Frame, Timber**) is usually applied to light wood construction.

    d. Lumber dimensions are called out in (**actual, nominal**) size.

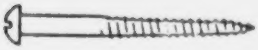
23. Identify the following types of wood connectors.



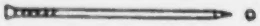
a. ______________________________



b. ______________________________

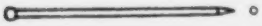


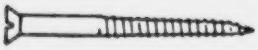
c. ______________________________



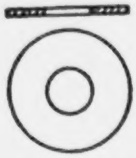
d. ______________________________

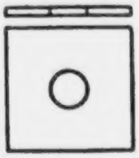
TEST





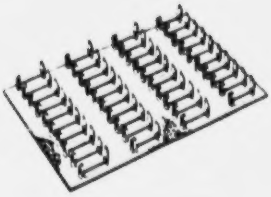
e. ______________________________ f. ______________________________

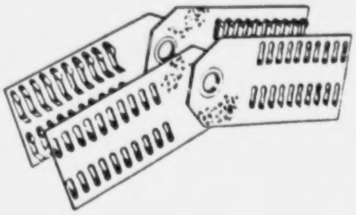




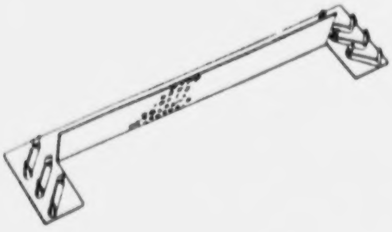
g. ______________________________ h. ______________________________

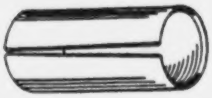
24. Identify the following types of framing connectors.





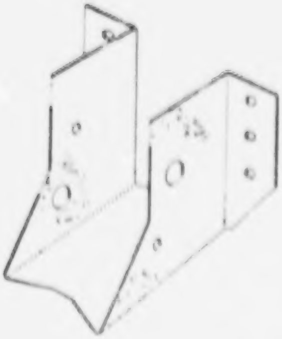
a. ______________________________ b. ______________________________



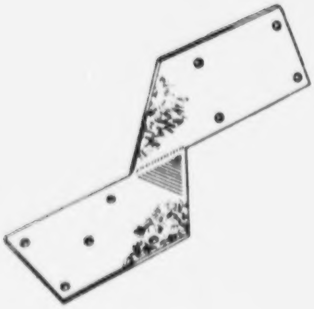


c. ______________________________ d. ______________________________

TEST



e. ______________________________



f. ______________________________

25. Select true statements concerning components of wood construction by placing an "X" next to the true statements.

_____a. Wood columns are square timbers rarely smaller than 12 × 12 inches and not larger than 3 × 3 feet.

_____b. Wood studs are used for dwellings to carry light loads and receive support from the material attached to them.

_____c. In wood frame construction the common depths for rafters are 8-12 inches.

_____d. In wood frame construction the common depths for joists are 4-6 inches.

_____e. For heavy timber the minimum thickness permitted for joists, beams, girders, and other members is 6" and minimum depth is 10".

_____f. Wood trusses are used to support roofs or floors.

26. Complete the following statements concerning heavy timber construction by correctly filling in the blanks.

a. Exterior walls are masonry or other noncombustible materials with a fire resistance rating of at least ____________ hours.

b. Floors and roofs are ______________________________.

c. Member sizes are determined by the ______________________________.

TEST

d. Interior girders are supported by ________________________________.

e. Transverse beams span the distance between lines of girders and are supported by ____________.

f. A tongue-and-groove or a laminated deck may span the space between ____________.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

27. Prepare detail drawings of structural steel members. (Assignment Sheet #1)

28. Draw to scale a concrete engineering drawing. (Assignment Sheet #2)

29. Detail a wood truss. (Assignment Sheet #3)

STRUCTURAL DRAFTING
UNIT XI

ANSWERS TO TEST

1.
   a. 7
   b. 6
   c. 10
   d. 4
   e. 1
   f. 13
   g. 3
   h. 9
   i. 2
   j. 11
   k. 8
   l. 12
   m. 5
   n. 19
   o. 24
   p. 15
   q. 16
   r. 22
   s. 26
   t. 28
   u. 23
   v. 17
   w. 21
   x. 20
   y. 14
   z. 29
   aa. 25
   bb. 18
   cc. 27

2. Structural drawing — All layout and detail drawings connected with the design and construction of buildings, bridges, viaducts, and similar structures in which structural steel, timber, concrete, and other building materials are used

3. Any four of the following:
   a. Buildings
   b. Bridges
   c. Dams
   d. Reinforced concrete foundations
   e. Manholes
   f. Box culverts
   g. Retaining walls

4.
   a. Steel
   b. Concrete
   c. Timber

5.
   a. 3
   b. 4
   c. 1
   d. 2
   e. 2
   f. 5
   g. 1
   h. 4
   i. 5

6.
   a. Structural tees
   b. Angles
   c. Plate
   d. Flat bar
   e. Wide flange shape
   f. Channel
   g. Beam

7. b, d, e

ANSWERS TO TEST

8. a. Angles — Gage line is measured from the back of the angle.
   b. Flange of a channel — Gage line is measured from the back of the channel.
   c. Flange of an I-beam — Gage line is measured from the center.

9. a. AISC
   b. Less

10. a. Aligned
    b. On top
    c. Farthest away from
    d. 5/16"
    e. Centerline
    f. Or
    g. Rise and run

11. a. Shape
    b. Depth
    c. Weight

12. a, b, c

13. a. Anchoring equipment
    b. Any one of the following:
       1) J-bolt
       2) Machine bolt
       3) Cane head anchor bolt (CHAB)
    c. Length
    d. Equipment base thickness

14. b

15. a. Eighths
    b. #11
    c. #2
    d. Steel
    e. Concrete slabs
    f. Wire gage

16. a. Channel slab
    b. Girder (I)
    c. Mono-wing (F) section
    d. Piles
    e. Hollow core slabs

17. a. 4
    b. 8
    c. 5
    d. 3
    e. 1
    f. 2
    g. 7
    h. 6

ANSWERS TO TEST

18. a. 3
    b. 1
    c. 2

19.

SYMBOLS		ABBREVIATIONS	
#	To indicate size of deformed bar	Bt	Bent
φ	Plain rounds, as spirals	T	Top
@	Spacing center to center	EF	Each face
⇆	Direction in which bars extend	Str	Straight
↔	Limits of area covered by bars	NF	Near face

20. a, d

21. a. Highway structure
    b. Wall and floor joint
    c. Underground structure — Clean-out
    d. Underground structure — Manhole

22. a. Timber
    b. Lumber
    c. Frame
    d. Nominal

23. a. Toggle bolt
    b. Machine bolt
    c. Round head screw
    d. Casing nail
    e. Finishing nail
    f. Flat head screw
    g. Circular flat washer
    h. Plate washer

24. a. Connector
    b. Hinge plate
    c. Web
    d. Romex
    e. Hanger
    f. Framing anchor

25. b, e, f

ANSWERS TO TEST

26.
  a. 2
  b. Heavy plank or laminated wood
  c. Length of span
  d. Wood columns, pipe, or steel structural shapes
  e. Metal hangers
  f. Beams

27.-29. Evaluated to the satisfaction of the instructor

COMPUTER APPLICATIONS
UNIT XII

UNIT OBJECTIVE

After completion of this unit, the student should be able to list computer applications for mapping and select true statements about the advantages of using computer for mapping applications. Competencies will be demonstrated by correctly performing the procedures outlined in the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match CAD equipment terms with the correct definitions.
2. Match CAD terminology with the correct definitions.
3. List hardware used in a CAD system and classify as input, output, or neither.
4. Select true statements concerning data input.
5. List types of data output.
6. Distinguish between digital and interactive computer graphics.
7. Identify types of computer drawings.
8. List methods of storing graphic information.
9. List advantages of using computers for mapping applications.
10. List computer applications for civil mapping.
11. Select true statements concerning the parts of an interactive data management system for mapping.
12. Research computer applications in the civil drafting field. (Assignment Sheet #1)

COMPUTER APPLICATIONS
UNIT XII

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Collect vendor brochures on CAD systems and compare applications and capabilities.
2. Invite a computer vendor to come in and demonstrate their CAD system.
3. Make a field trip to a civil engineering firm and observe the computer applications.
4. Make a display board of various computer drawings and their mapping application.
5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1 — Computer-Aided Drafting System — Microcomputer
2. TM 2 — Computer-Aided Drafting System — Large Computer

CONTENTS OF THIS UNIT

3. TM 3 — Computer Line Drawing
4. TM 4 — Computer Pictorial Drawing

D. Assignment Sheet #1 — Research Computer Applications in the Civil Drafting Field

E. Test

F. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. Wattles, Gurdon. *Survey Drafting.* Orange, CA: Gurdon H. Wattles Publications, 1977.

B. Bies, John and Robert Long. *Mapping and Topographic Drafting.* Cincinnati, OH: South-Western Publishing Co., 1983.

C. USGS Annual Report, Fiscal Year 1979, The Quiet Revolution in Mapping. U.S. Dept. of the Interior.

D. Houston Geographic Information Municipal Management System, Dr. Francis L. Hanigan, TCB Data Systems Abstract paper, 1983 ASCM — ASP Fall Convention, Salt Lake City, Utah.

E. New Mexico Natural Resources Information System, pamphlet, Natural Resources Department, Santa Fe, New Mexico 87503, 1983.

F. Northway-Gestalt Corporation, Ontario, Canada. Brochure for (GPM) Gestalt Photo Mapper.

G. Land Resource Management, brochure. Measuronics Corporation, Grent Fall, MT 59401.

H. VLS Systems, Inc., brochure. Irvine, CA 92714.

COMPUTER APPLICATIONS
UNIT XII

INFORMATION SHEET

I. **CAD equipment terms and definitions**

A. Automated digitizer — Utilizes a television camera on an automated drafting machine to follow the line being digitized for output digits according to stored information in CPU

B. Cathode ray tube (CRT) — A TV-like display that can be a storage tube, plasma display, or refresh tube display

C. Central processing unit (CPU) — The main controlling unit in a computer system containing the system's arithmetic, logic, primary storage, and controls of input and output peripheral devices

D. Computer — An electronic information-handling machine capable of performing arithmetic calculations and making logical decisions under the control of programs

E. Computer-aided drafting (CAD) — Process system used in designing industrial products and the production of graphic drawings with the aid of the computer and its related input and output devices

(NOTE: This system is often called the Interactive Graphics System — IGS. In this unit the computer-aided system will be referred to as CAD.)

F. Digitizer tablet — An input device using stored graphic symbols in the CPU where a designer uses a light pen, stylus, or free-moving cursor by positioning on tablet for each symbol to create a drawing on CRT

G. Floppy disk — A magnetic, flexible, plastic disk used for storage of data

H. Free-moving cursor — Contains a sensing coil connected to the digitizer control used for sighting a drawing coordinate X-Y points on the digitizer

I. Hard copier — An output device that forms graphic and character images by electronic signals on paper from CPU

J. Joy stick — Used as a graphic input and cursor positioning device to the CRT and CPU

K. Keyboard console — An input device, consisting of ASCII character keys, numeric keys, and math function keypad used by the computer operator before, during, and after running programs

INFORMATION SHEET

L. Light pen — An input device used with a refreshed-picture display to create various edges, contours, or other features in a photographic image

M. Line printer — An output device that prints one line of character information at a time from CPU

N. Magnetic tape — Medium on which data is recorded in the form of magnetized spots on the surface of magnetically sensitive coated tape

O. Manual digitizer — An input device where digit or X-Y points are located by positioning the free-moving cursor or stylus on an electromagnetic grid embedded in the digitized board

P. Microcomputer — Small, inexpensive computer that has a CPU and one or more input/output devices

Q. Peripheral devices — Various devices that are used in the CAD system in which data is input, stored, retrieved, and output from the CPU

(NOTE: These devices are external to the CPU.)

R. Plotter — An X-Y type output device, usually drum or bed form, that produces line drawings on paper with a pen controlled by instructions from CPU or tape controller

S. Stylus — Used to locate coded programs of X-Y points by pressing at the point of drawing line intersect on digitizer board and input to CRT

II. CAD terminology and definitions

A. Alphanumeric — The set of letters A-Z, the numerals 0-9, and various punctuation marks and special characters

B. American Standard Code for Information Interchange (ASCII) — Used as a standard code of alphanumeric characters, symbols, and special control characters

C. Beginners All-Purpose Symbolic Instruction Code (BASIC) — A symbolic English-like programming language

D. Binary code — Two-digit numbering system composed of only 0 and 1

E. Bit — Binary digit (0 or 1); the smallest unit of information that can be recognized by a computer

F. Byte — A collection of eight bits

G. Chips — Miniaturized integrated circuits which compose ROM memory

INFORMATION SHEET

H. COmmon Business Oriented Language (COBOL) — A higher-level source programming language designed to process large files used by business

I. Compiler — A computer program used to translate high-level source language programs into machine language programs

J. Computer language — A set of mathematical commands such as add, divide, or multiply, or functional commands to "store in memory," "delete," or "draw"

K. Cursor — Flashing rectangular dot or cross hair that indicates the current position on the screen

L. Data — Information; facts of all kinds

M. Digit — Any number from 0 through 9

N. File — Collection of related data treated as a unit

O. FORmula TRANslation (FORTRAN) — A high-level algebraic and logical language used in engineering and graphic systems

P. Graphics — Computer output that is composed of lines rather than letters, numbers, or symbols

Q. Hardware — Any physical equipment that is part of the CAD system

R. Input — Signals or data transmitted **to** a microcomputer system

S. Interface — The interconnecting methods or devices used in the CAD hardware system

Example: RS-232-C interface

T. K — Symbol denoting 1024 units (bytes) of storage

U. Machine language — A programming language that can be interfaced directly by the internal circuitry of the computer

V. Menu — A display of selections that may be chosen, typically on a video display device

W. Output — Signals or data transmitted **from** a microcomputer system

X. Program — Step-by-step instructions which tell the computer what to do

INFORMATION SHEET

Y. Random access memory (RAM) — Memory that can both be written into and read

Z. Raster scan — A CRT scanning system where the electron beam moves horizontally across all X values first at each Y level, moving down each Y level until the screen is scanned

AA. Read only memory (ROM) — That portion of the system memory that cannot be changed and may be read but not written into

BB. Resolution — A measure of the number of separately addressable positions on the coordinate grid

Example: If a 10 inch display has 1023 addressable points along each X-Y axis, the resolution is 1023/10 or 102.3 points per inch

CC. Routine — A sequence of instructions to carry out a certain function

DD. Software — Prepared programs that simplify CPU operations that cause hardware to function

EE. Statement — A complete instruction in machine language such as BASIC or FORTRAN

FF. Variable — A quantity that can take on any of a given set of values

III. **Hardware used in a CAD system** (Transparencies 1 and 2)

A. Central processing unit (CPU)

B. Input devices

(NOTE: Some devices are both input and output.)

1. Keyboard
2. Digitizer
3. Plotter

   (NOTE: A joy stick and an X-Y beam are used on some plotters.)

4. Light pen
5. Card reader

C. Output devices

1. Video display monitor/screen

   (NOTE: A combined monitor and keyboard is often referred to as a terminal.)

INFORMATION SHEET

2. Plotter
3. Printer
4. Hard copier
5. Cursor/stylus/light pen
6. Storage devices
    a. Magnetic tape
    b. Floppy disks/diskettes

IV. Data input

A. Data input is the process of placing data into the computer.

B. Input consists of data itself with instructions on what to do with the data.

C. Programs are the directions for what is to be done with the data.

D. Programs make up the software for the computer system.

V. Data output

A. Hardware will determine the form the output will be displayed.

B. Output can be

1. Graphic image, not hardcopy (on monitor screen only)
2. Graphic image, hardcopy
3. Calculations
4. Compiled information

    Example: Base map with overlay of water lines, sewer and electric and gas lines

VI. Types of computer graphics

A. Digital computer graphics

1. Input is given in digital form.
2. Input is given by means of
    a. Punched cards
    b. Punched tape
    c. Magnetic tape

INFORMATION SHEET

3. Requires little or no human intervention during draw stage of the program.
4. Types of digital graphic drawing machines
    - a. Flat bed plotter
    - b. Drum plotter
5. Disadvantage: Does not allow for two way communication between computer and user.

B. Interactive computer graphics

1. Is the continual and instant communication between a person and the computer.
2. Visual display (CRT) is required.
3. Input is accomplished by
    - a. Keyboarding
    - b. Digitizing
    - c. Using light pens and joy sticks
4. Has layer capabilities for storage of information.
5. Graphic image can be changed dynamically
    - a. Rotate
    - b. Reduce and enlarge
    - c. Capture
    - d. Scale
    - e. Screen (scroll)

(NOTE: Often digital graphics and interactive graphics are used in conjunction with each other.)

INFORMATION SHEET

VII. Types of computer drawings

A. Line (Transparency 3)

1. Most common type of computer graphics.
2. Can be shown in multiple colors.
3. Lines can become symbols by varying the line widths and shapes (line fonts).

B. Pictorial (Transparency 4)

1. Presents life-like illustration of surface features.
2. Easier to interpret and visualize.

VIII. Methods of storing graphic information

A. Floppy disks/diskettes

B. Hard disks

C. Tape

IX. Advantages of using computers for mapping applications

A. Keeps data accurate and more consistent.

B. Makes tedious, error-prone calculations easier and faster.

C. Provides a broad base of data to build on.

D. Produces final drawings faster.

E. Allows simultaneous multi-user access to a common data base.

F. Helps locate and find data about a particular area through a central resource.

G. Simplifies data editing.

H. Creates a library of symbols to be used, moved, and oriented as often as needed.

I. Allows use of layers. Elements of a project can be assigned to different layers.

INFORMATION SHEET

J. Allows storage of large projects.

K. Simplifies data management and billing. The time spent on a project can be recorded and used for billing purposes.

L. Improves security. Projects in a computer can be accessed only by a password or I.D. number.

M. Has remote office capability.

X. Computer applications for civil mapping

(NOTE: All information is stored in the computer and geographically referenced. Data output can be in map form or tabular form.)

A. Calculate volume for water reservoir storage, stock piles, and open pit mining.

B. Digital terrain elevation model

C. Build stereo models of aerial photographs.

D. Computerize search for cartographic information

1. Aerial photographs

(NOTE: The following address and phone number can be used to help locate aerial photographs:

Aerial Photography Field Office
User Services
2222 West 2300 South
P.O. Box 30010
Salt Lake City, UT 84130
301/524-5856

a. High altitude aerial photos

1) Skylab, Apollo, and Gemini satellite photos

2) Landsat RBV and MSS satellite images

3) NASA high altitude photos

b. Lower altitude aerial photos

1) USGS

2) BLM

3) Bureau of Reclamation

4) United States Forest Service

INFORMATION SHEET

2. Resource information
    a. Geology
    b. Soils
    c. Vegetation
    d. Land ownership

E. Surface measurement

F. Boundary information in digital form

G. Integration of many types of maps into a computer-based system for assessment of areas such as environment or land use planning

H. Map compilation through computer-driven plotters

I. Contour plotting

J. Plan views

K. Profile and cross sections plotting to specifications

L. Grade slopes and mass diagrams

M. Plotting isometric views of terrain from different perspectives

N. Develop data bases for terrain elevation information for forest management, municipal utilities, or aerial navigation

O. Balancing survey data, field note reductions

P. Master directory of standard notes

Q. Calculate bearing loads for structural members

R. Store often used standard details for future use.

XI. Parts of an interactive data management system for mapping

(NOTE: Information is based on the Metrocom Data Base System used for Houston, Texas. A mapping system that is integrated through a data base management system can provide many users different information about the same piece of land. All information is pulled together in one storage mechanism — the computer.)

A. Data base

1. All data stored in the system is indexed to digital planimetric maps of the city, based on photogrammetric techniques.

2. Coordinates of brass survey markers are the foundation of the data base.

INFORMATION SHEET

3. Entire land mass is stored as a continuous map.

4. Area is broken into blocks covering a specific acreage of land with each block tied to surrounding blocks.

5. Each block is subdivided into layers.

   Examples: Annotation, roadways, railroads, drainage, sidewalks, fences, parking lots, bridges, dams, power plants

B. Graphic files for real property provide information to draw

1. City, county, and school district lines
2. Subdivision boundaries
3. Historic land survey lines
4. City, county, state, and federal right-of-ways
5. Nongraphic attributes are stored and can be listed out such as
   a. Land use classifications
   b. Tax account numbers
   c. Names of property owners
   d. Legal descriptions
   e. Deeded and calculated acreage
   f. Date and price of last sale
   g. Assessed value of land and improvements, etc.

C. Graphics files for city-owned utilities

1. Set up on individual layers in the computer
   a. Network of roads and bridges
   b. Water and storm sewer layout
   c. Sanitary systems
   d. Gas distribution
   e. Telephone and cable lines

INFORMATION SHEET

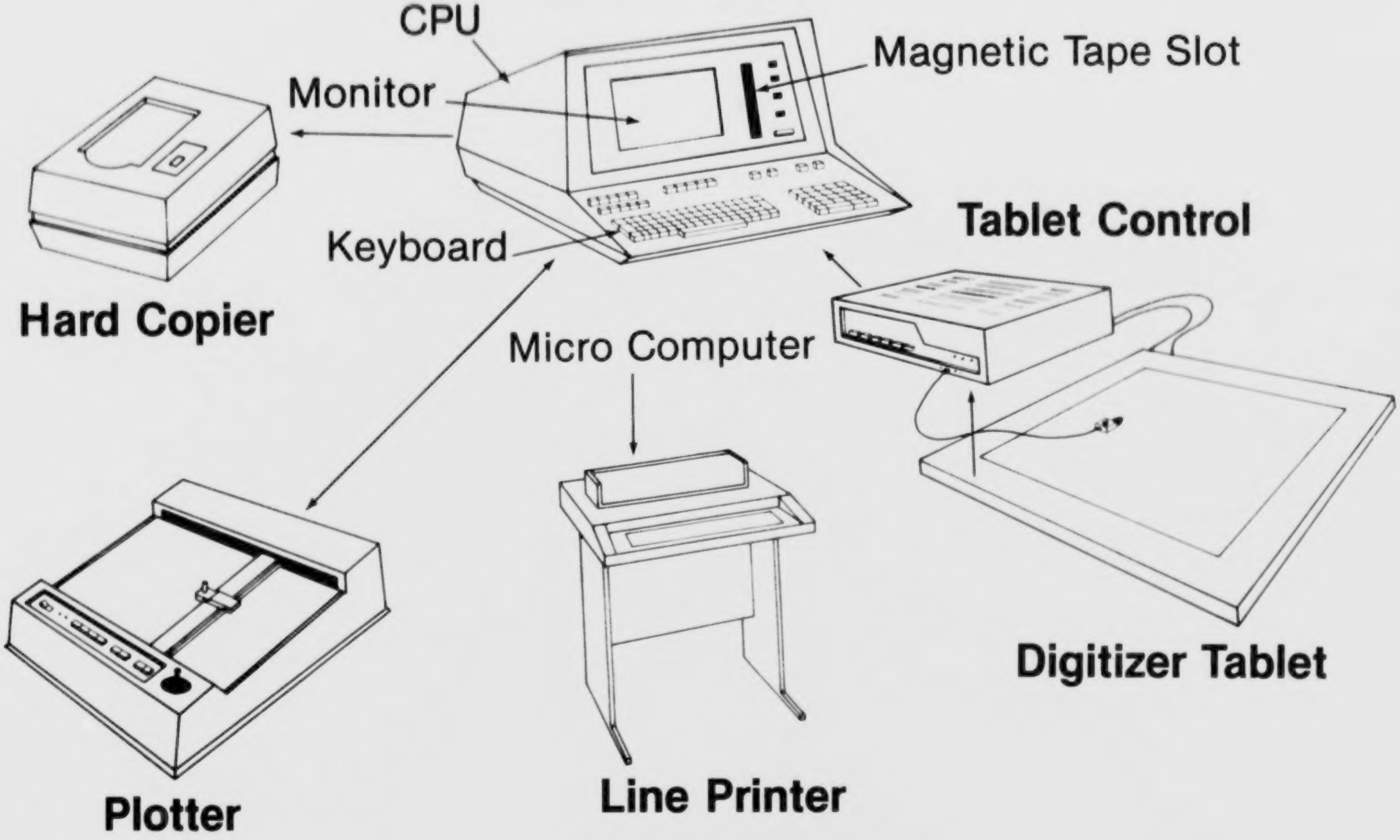
2. Nongraphic data

    a. Roads — Classification, number of lanes, curb status, maintenance information

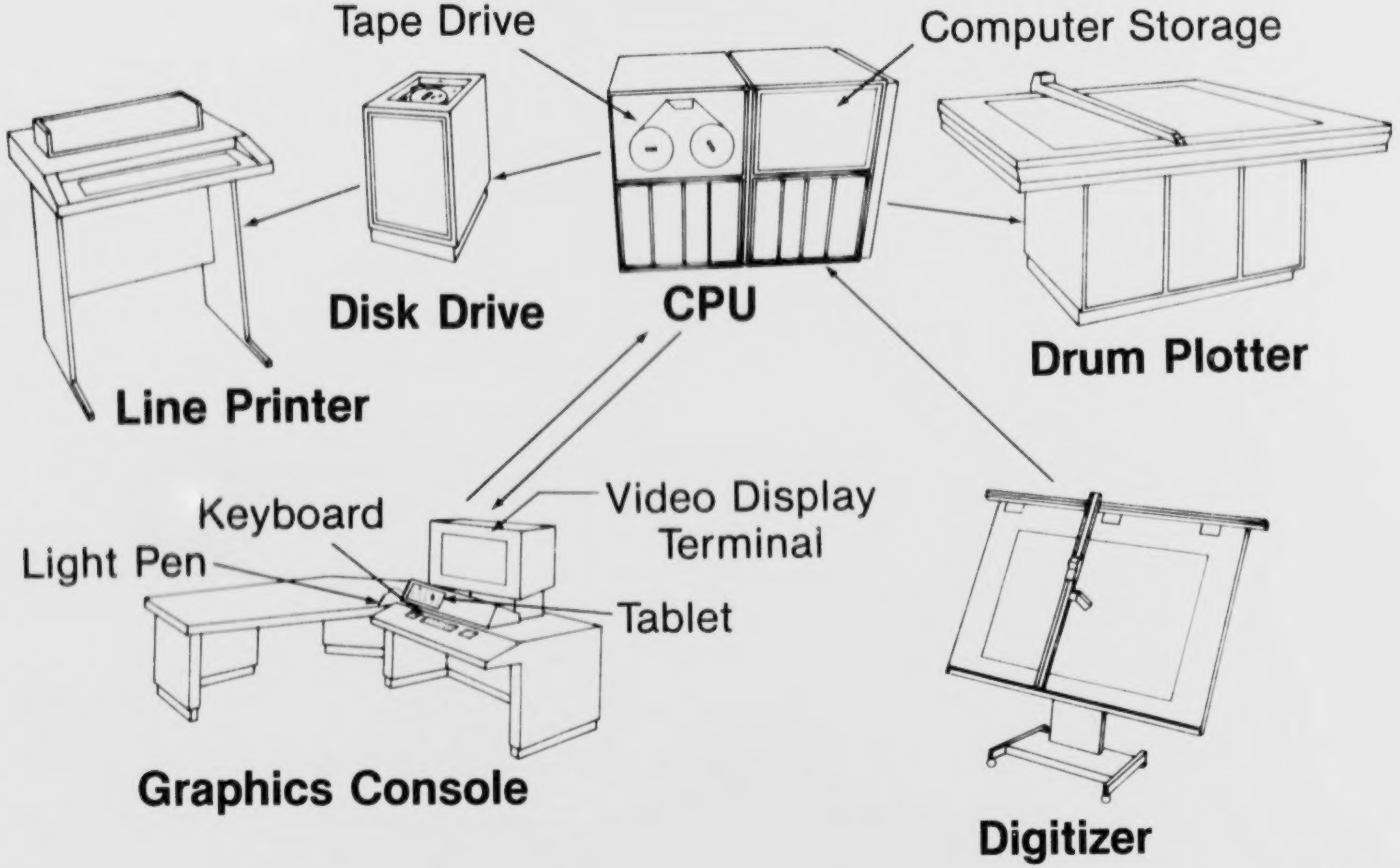
    b. Manholes — Various invert elevations type construction, utility served

    c. Lines — Flow elevations at each end, type of material, status (proposed, existing, abandoned)

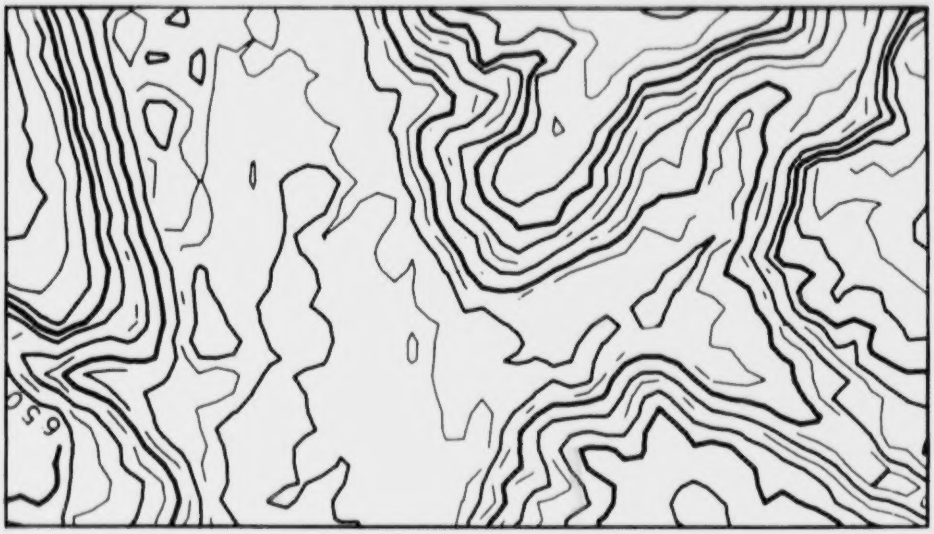
Computer-Aided Drafting System
Microcomputer


CPU
Magnetic Tape Slot
Monitor
Keyboard
Tablet Control
Hard Copier
Micro Computer
Digitizer Tablet
Plotter
Line Printer

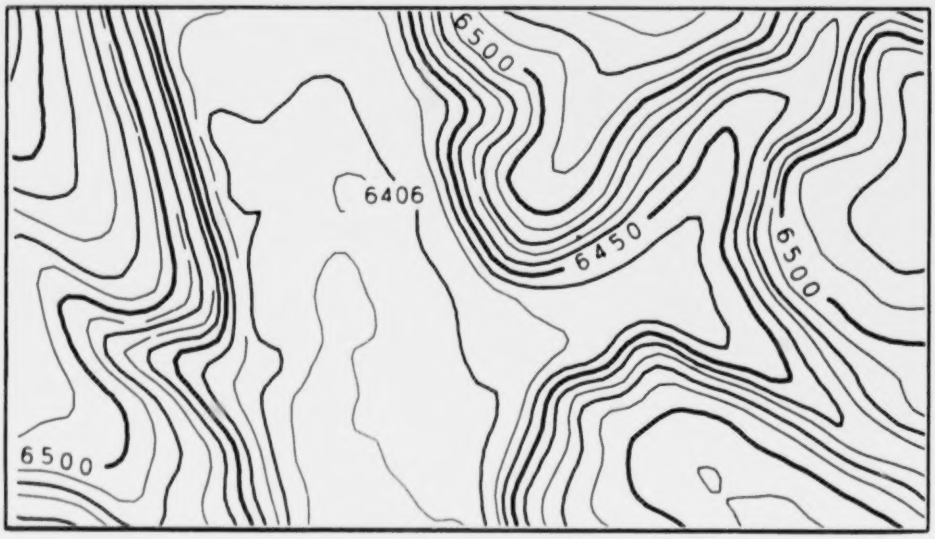
Computer-Aided Drafting System
Large Computer


Tape Drive
Computer Storage
Disk Drive
CPU
Drum Plotter
Line Printer
Keyboard
Video Display Terminal
Light Pen
Tablet
Graphics Console
Digitizer

Computer Line Drawing



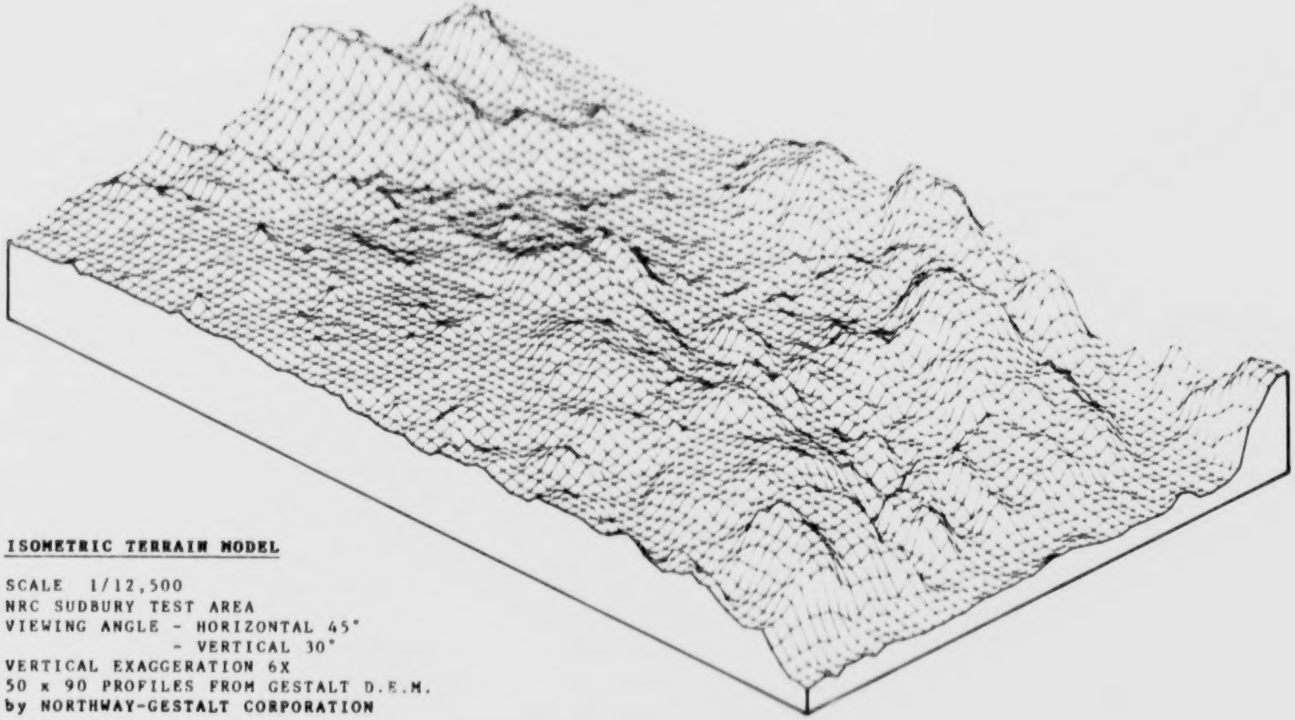
Original Contour Plot


6500
6406
6450
6500
6500

Contour Plot after Filtering and Smoothing

Courtesy of Northway-Gestalt Corporation

Computer Pictorial Drawing



ISOMETRIC TERRAIN MODEL

SCALE 1/12,500
NRC SUDBURY TEST AREA
VIEWING ANGLE - HORIZONTAL 45°
- VERTICAL 30°
VERTICAL EXAGGERATION 6X
50 x 90 PROFILES FROM GESTALT D.E.M.
by NORTHWAY-GESTALT CORPORATION

Courtesy of Northway-Gestalt Corporation

COMPUTER APPLICATIONS
UNIT XII

ASSIGNMENT SHEET #1 — RESEARCH COMPUTER APPLICATIONS IN THE CIVIL DRAFTING FIELD

Directions:

1. Choose three different places in your area that may use computer applications.
   a. Municipal agency
   b. Private civil engineering firm
   c. Government mapping agency
2. Visit or write each place and ask the following questions:

   (NOTE: Your instructor may wish for you to accomplish this assignment as a group to lessen the inconvenience to businesses.)

   a. What type of computer graphics system are they using

   ____

   b. How many work stations do they have? ______________________________

   How many remote work stations? ______________________________

   c. What method are they using for data storage?

   ____

   d. What mapping applications are they using the system for?

   ____

   ____

   ____

   ____

   ____

   ____

   e. What kind of equipment are they using for data output? ______________________________

   ____

ASSIGNMENT SHEET #1

f. Who uses the computer graphics system?
   ____ Management
   ____ Engineers
   ____ Drafters
   ____ Secretarial/support staff

g. What method do they use for data input?

   ____

h. Do they use the layering capabilities? ____________________

i. Describe how: ____

   ____

   ____

   ____

j. Write a brief description of how they have their data base set up. __________

   ____

   ____

   ____

   ____

k. Give an overall impression of the organization structure for the CAD application.

   ____

   ____

   ____

l. Do they hire entry level civil drafters with CAD training? ______________

COMPUTER APPLICATIONS
UNIT XII

NAME ________________________

TEST

1. Match the CAD equipment terms on the right with the correct definitions.

(NOTE: The terms on this page match the definitions on this page.)

______a. An input device using stored graphic symbols in the CPU where a designer uses a light pen, stylus, or free-moving cursor by positioning on tablet for each symbol to create a drawing on CRT

______b. An X-Y type output device, usually drum or bed form, that produces line drawings on paper with a pen controlled by instructions from CPU or tape controller

______c. Medium on which data is recorded in the form of magnetized spots on the surface of magnetically sensitive coated tape

______d. Process system used in designing industrial products and the production of graphic drawings with the aid of the computer and its related input and output devices

______e. Various devices that are used in the CAD system in which data is input, stored, retrieved, and output from the CPU

______f. A TV-like display that can be a storage tube, plasma display, or refresh tube display

______g. Contains a sensing coil connected to the digitizer control used for sighting a drawing coordinate X-Y points on the digitizer

______h. An electronic information-handling machine capable of performing arithmetic calculations and making logical decisions under the control of programs

______i. Used as a graphic input and cursor positioning device to the CRT and CPU

______j. Used to locate coded programs of X-Y points by pressing at the point of drawing line intersect on digitizer board and input to CRT

______k. A magnetic, flexible, plastic disk used for storage of data

1. Cathode ray tube (CRT)
2. Computer
3. Computer-aided drafting (CAD)
4. Digitizer tablet
5. Floppy disk
6. Free-moving cursor
7. Joy stick
8. Magnetic tape
9. Peripheral devices
10. Plotter
11. Stylus

TEST

(NOTE: The terms on this page match the definitions on the page.)

_____l. The main controlling unit in a computer system containing the system's arithmetic, logic, primary storage, and controls of input and output peripheral devices

_____m. An input device used with a refreshed-picture display to create various edges, contours, or other features in a photographic image

_____n. An input device, consisting of ASCII character keys, numeric keys, and match function keypad used by the computer operator before, during, and after running programs

_____o. An input device where digit or X-Y points are located by positioning the free-moving cursor or stylus on an electromagnetic grid embedded in the digitized board

_____p. An output device that prints one line of character information at a time from CPU

_____q. Small, inexpensive computer that has a CPU and one or more input/output devices

_____r. Utilizes a television camera on an automated drafting machine to follow the line being digitized for output digits according to stored information in CPU

_____s. An output device that forms graphic and character images by electronic signals on paper from CPU

12. Automated digitizer
13. Central processing unit (CPU)
14. Hard copier
15. Keyboard console
16. Light pen
17. Line printer
18. Manual digitizer
19. Microcomputer

2. Match the CAD terminology on the right with the correct definitions.

(NOTE: The terms on this page match the definitions on this page.)

_____a. Any physical equipment that is part of the CAD system

_____b. A higher-level source programming language designed to process large files used by business

_____c. Memory that can both be written into and read

_____d. Any number from 0 through 9

_____e. A high-level algebraic and logical language used in engineering and graphic systems

_____f. A programming language that can be interfaced directly by the internal circuitry of the computer

1. COBOL
2. Digit
3. FORTRAN
4. Hardware
5. Machine language
6. Random access memory

TEST

(NOTE: The terms on this page match the definitions on this page.)

______g. Signals or data transmitted to a microcomputer system

______h. A symbolic English-like programming language

______i. A complete instruction in machine language such as BASIC or FORTRAN

______j. The interconnecting methods or devices used in the CAD hardware system

______k. Step-by-step instructions which tell the computer what to do

______l. Used as a standard code of alphanumeric characters, symbols, and special control characters

______m. Information; facts of all kinds

______n. Collection of related data treated as a unit

______o. That portion of the system memory that cannot be changed and may be read but not written into

______p. A quantity that can take on any given set of values

______q. Flashing rectangular dot or cross hair that indicates the current position on the screen

______r. A sequence of instructions to carry out a certain function

______s. Prepared programs that simplify CPU operations that cause hardware to function

______t. Binary digit (0 or 1); the smallest unit of information that can be recognized by a computer

7. American Standard Code for Information Interchange (ASCII)
8. BASIC
9. Bit
10. Cursor
11. Data
12. File
13. Input
14. Interface
15. Program
16. Read only memory (ROM)
17. Routine
18. Software
19. Statement
20. Variable

TEST

(NOTE: The terms on this page match the definitions on this page.)

_____u. Computer output that is composed of lines rather than letters, numbers, or symbols

_____v. Symbol denoting 1024 units (bytes) of storage

_____w. The set of letters A-Z, the numerals 0-9, and various punctuation marks and special characters

_____x. Signals or data transmitted **from** a microcomputer system

_____y. A set of mathematical commands such as add, divide, or multiply, or functional commands to "store in memory," "delete," or "draw"

_____z. Two-digit numbering system composed of only 0 and 1

_____aa. A measure of the number of separately addressable positions on the coordinate grid

_____bb. A collection of eight bits

_____cc. A CRT scanning system where the electron beam moves horizontally across all X values first at each Y level, moving down each Y level until the screen is scanned

_____dd. Miniaturized integrated circuits which compose ROM memory

_____ee. A display of selections that may be chosen, typically on a video display device

_____ff. A computer program used to translate high-level source language programs into machine language programs

21. Alphanumeric
22. Binary code
23. Byte
24. Chips
25. Compiler
26. Computer language
27. Graphics
28. K
29. Menu
30. Output
31. Raster scan
32. Resolution

TEST

3. List six pieces of hardware used in a CAD system and classify as input, output, or neither.

Example: Hard copier — Output device

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

4. Select true statements concerning data input by placing an "X" next to the true statements.

______a. Data input is the process of placing data into the computer.

______b. Input consists of data itself with instructions on what to do with the data.

______c. Programs are the directions for what is to be done with the data.

______d. Programs make up the hardware for the computer system.

5. List two types of data output.

a. ____________________

b. ____________________

6. Distinguish between digital and interactive computer graphics by placing a "D" next to the characteristics of digital computer graphics and an "I" next to those for interactive computer graphics.

______a. Is the continual and instant communication between a person and the computer.

______b. Requires little or not human intervention during draw stage of the program.

______c. Has layer capabilities for storage of information.

______d. Input is given by means of punched cards, punched tape, or magnetic tape.

______e. Input is given in digital form.

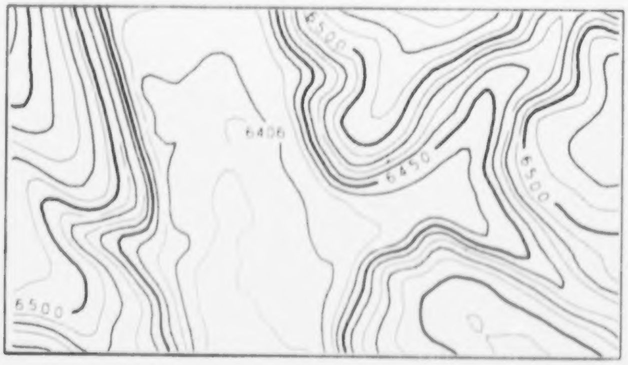
______f. Visual display (CRT) is required.

______g. One disadvantage is that it does not allow for two way communication between computer and user.

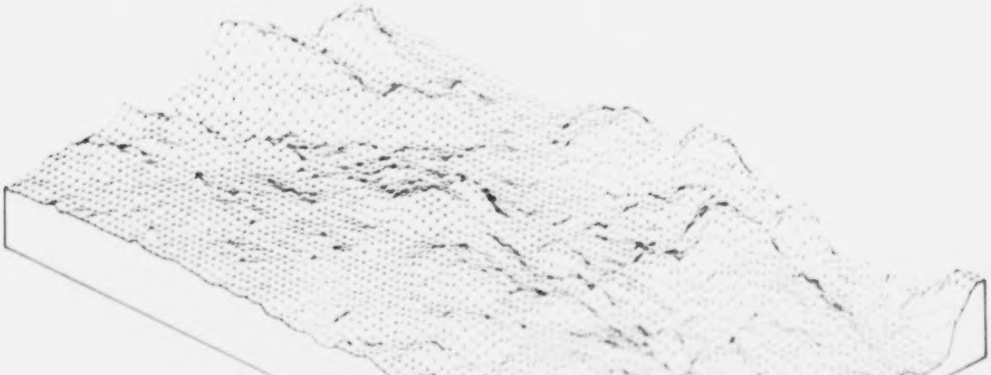
______h. Input is accomplished by keyboarding, digitizing, and using light pens and joy sticks.

TEST

7. Identify the following types of computer drawings.


6500
6406
6450
6500
6500

a. ______________________________



b. ______________________________

TEST

8. List two methods of storing graphic information.

a. ______________________

b. ______________________

9. List seven advantages of using computers for mapping applications.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

10. List eight computer applications for civil mapping.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

11. Select true statements concerning the parts of an interactive data management system for mapping by placing an "X" next to the true statements.

_____a. All data stored in the system is indexed to digital planimetric maps of the city, based on photogrammetric techniques.

_____b. Coordinates of building corners are the foundation of the data base.

_____c. Entire land mass is stored as a single map.

TEST

_____d. Area is broken into blocks covering a specific acreage of land with each block tied to surrounding blocks.

_____e. Each block is subdivided into layers.

_____f. Graphic files for real property provide information to draw city, county, and school district lines and subdivision boundaries.

_____g. Graphics files for city-owned utilities are set up on individual layers in the computer such as for network of roads and bridges, water and storm sewer layout, and sanitary systems.

(NOTE: If the following activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

12. Research computer applications in the civil drafting field. (Assignment Sheet #1)

COMPUTER APPLICATIONS
UNIT XII

ANSWERS TO TEST

1. a. 4
   b. 10
   c. 8
   d. 3
   e. 9
   f. 1
   g. 6
   h. 2
   i. 7
   j. 11
   k. 5
   l. 13
   m. 16
   n. 15
   o. 18
   p. 17
   q. 19
   r. 12
   s. 14

2. a. 4
   b. 1
   c. 6
   d. 2
   e. 3
   f. 5
   g. 13
   h. 8
   i. 19
   j. 14
   k. 15
   l. 7
   m. 11
   n. 12
   o. 16
   p. 20
   q. 10
   r. 17
   s. 18
   t. 9
   u. 27
   v. 28
   w. 21
   x. 30
   y. 26
   z. 22
   aa. 32
   bb. 23
   cc. 31
   dd. 24
   ee. 29
   ff. 25

3. Any six of the following:
   a. Central processing unit
   b. Input devices
      1) Keyboard
      2) Digitizer
      3) Plotter
      4) Light pen
      5) Card reader
   c. Output devices
      1) Video display monitor/screen
      2) Plotter
      3) Printer
      4) Cursor/stylus/light pen
      5) Storage devices
         a) Magnetic tape
         b) Floppy disks/diskettes

4. a, b, c

5. Any two of the following:
   a. Graphic image, not hardcopy (on monitor screen only)
   b. Graphic image, hardcopy
   c. Calculations
   d. Compiled information

ANSWERS TO TEST

6. a. I
   b. D
   c. I
   d. D
   e. D
   f. I
   g. D
   h. I

7. a. Line drawing
   b. Pictorial drawing

8. Any two of the following:
   a. Floppy disks/diskettes
   b. Hard disks
   c. Tape

9. Any seven of the following:
   a. Keeps data accurate and more consistent.
   b. Makes tedious, error-prone calculations easier and faster.
   c. Provides a broad base of data to build on.
   d. Produces final drawings faster.
   e. Allows simultaneous multi-user access to a common database.
   f. Helps locate and find data about a particular area through a central resource.
   g. Simplifies data editing.
   h. Creates a library of symbols to be used, moved, and oriented as often as needed.
   i. Allows use of layers. Elements of a project can be assigned to different layers.
   j. Allows storage of large projects.
   k. Simplifies data management and billing. The time spent on a project can be recorded and used for billing purposes.
   l. Improves security. Projects in a computer can be accessed only by a password or I.D. number.
   m. Has remote office capability.

10. Any eight of the following:
    a. Calculate volume for water reservoir storage, stock piles, and open pit mining.
    b. Digital terrain elevation model
    c. Build stereo models of aerial photographs.
    d. Computerize search for cartographic information (such as aerial photographs and resource information)
    e. Surface measurement
    f. Boundary information in digital form
    g. Integration of many types of maps into a computer-based system for assessment of areas such as environment or land use planning
    h. Map compilation through computer-driven plotters
    i. Contour plotting
    j. Plan views
    k. Profile and cross sections plotting to specifications
    l. Grade slopes and mass diagrams
    m. Plotting isometric views of terrain from different perspectives
    n. Develop data bases for terrain elevation information for forest management, municipal utilities, or aerial navigation
    o. Balancing survey data, field note reductions
    p. Master directory of standard notes
    q. Calculate bearing loads for structural members
    r. Store often used standard details for future use.

11. a, d, e, f, g

12. Evaluated to the satisfaction of the instructor